PRESTRESSED CONCRETE INSTITUTE

Vol. 3 Dec. 1958 No. 3

JOURNAL

OF THE PRESTRESSED CONCRETE INSTITUTE

IN THIS ISSUE

Prestressed Concrete in Northern Europe ..... Ben C. Gerwick, Jr. and Prof. T. Y. Lin

Errata to Proceedings of World Conference on Prestressed Concrete

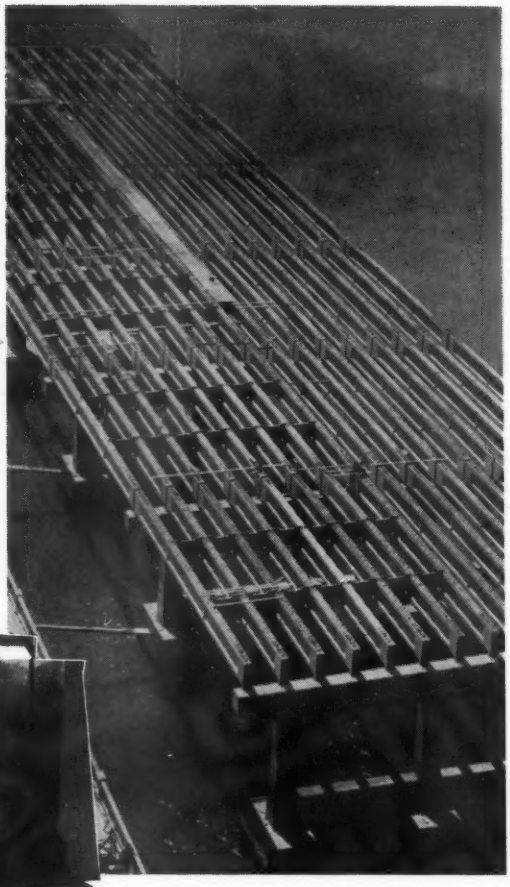
Fire Ratings and Building Codes ..... Edwin N. Searl

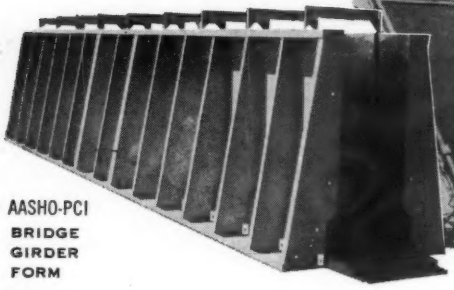
Prestressed Concrete in Russia ..... Prof. T. Y. Lin and Ben C. Gerwick, Jr.

mass-produce
your precast
bridge sections ... use

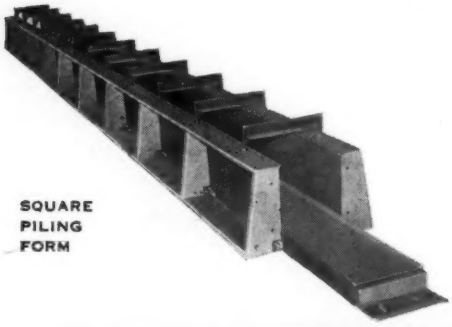
WATCO

STEEL FORMS





AASHO-PCI
BRIDGE
GIRDER
FORM



SQUARE
PILING
FORM

On big volume bridge jobs you will be time and money ahead when you cast piling and girders in WATCO steel forms.

These forms are designed for mass production of all State Road Department and AASHO-PCI bridge girders. Available in 10 ft. sections which provide ease in handling in lengths up to 50 ft. — at any one time. Removable side forms enable you to turn over beds quicker and set up additional lines.

WATCO forms are a product of the pioneer organization in fabrication of steel forms for precast prestressed concrete. They offer vital advantages found in no other competitive equipment. One of our representatives will be glad to supply complete details. Write today for his assistance.

Manufacturers of WATCO Steel Forms

PLANT CITY STEEL CORP. · P. O. BOX 1308 · PLANT CITY, FLORIDA

CONVERTO MANUFACTURING COMPANY · CAMBRIDGE CITY, INDIANA

NOW... from Laclede

7 WIRE STRAND

for prestressed concrete

7 wire strand is the newest addition to Laclede's line of quality reinforcing products. This product combines Laclede Steel's half century of experience as a national producer and supplier of construction steels with the recognized leadership of the company in the production of high carbon spring and rope wire.

Other Laclede quality reinforcing products

- **MULTI-RIB REINFORCING BARS**
  available in standard reinforcing grades and in special grades with 60,000 psi and 75,000 psi yield strengths.
- **PREFABRICATED GIRDER BEAM AND SLAB REINFORCEMENT**
- **WELDED WIRE FABRIC**
- **ACCESSORIES FOR PRECASTING**
- **HOOKS AND ANCHORS**

LACLEDE®

LACLEDE STEEL COMPANY

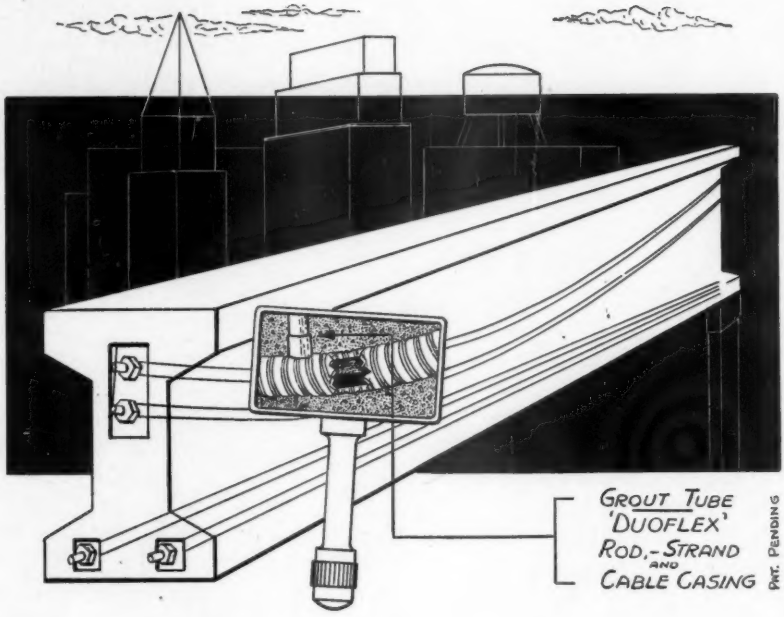
GENERAL OFFICES *St. Louis, Missouri*

DISTRICT OFFICES

Chicago, Illinois
Dallas, Texas
Detroit, Michigan
Houston, Texas
Kansas City, Missouri
Memphis, Tennessee
Moline, Illinois
New Orleans, Louisiana
Tampa, Florida

BEST FOR POST-TENSIONING . . .

DUOFLEX



There is only one DUOFLEX casing specially designed for post-tensioning prestressed concrete used over bar, strand, or cable

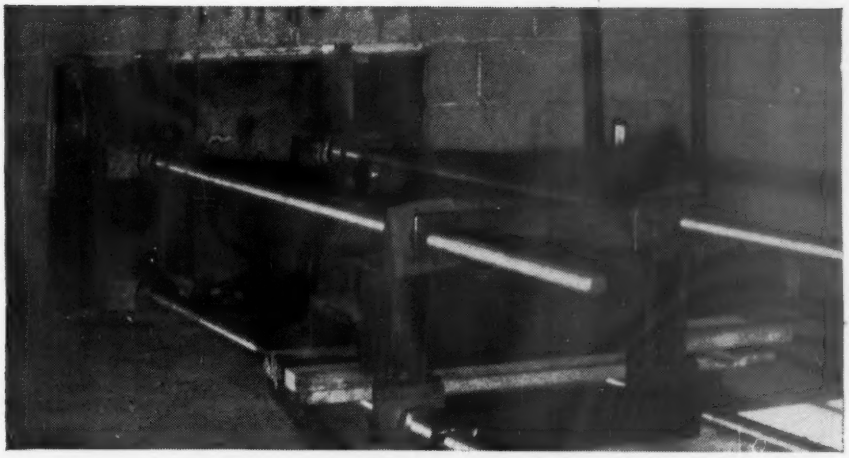
DUOFLEX is designed for the greatest possible economy to keep your bids low — providing the best possible price for casing delivered to the job-site.

DUOFLEX casing has no peer. It is designed right and made right.
Specify DUOFLEX casing and Grout Connections and be right on all counts.

FLEXICO PRODUCTS, INC.

Flexible Metal Hose and Tubing for Industry

Metuchen, New Jersey



How Ruby Precast Concrete, Inc., economizes with Meridian Steel Jacking Rods

Ruby Precast Concrete, Inc., Madisonville, Ky. is typical . . . This alert firm specifies Meridian Steel Jacking Rods.

Meridian rods assure Ruby Precast Concrete safe loads in excess of what normal steels deliver; this is true even with steel diameters reduced as much as ½" or more! Naturally, reduced diameters mean savings. So do corresponding reductions in the sizes of related hardware – hexagon nuts, split nuts, collars and washers. In addition to economy, Meridian rods' reduced diameters provide the advantage of weight reduction and the elimination of problems associated with weight.

Meridian rods are fabricated exclusively of our own Merico steel. Merico steel is heat-treated and stress-relieved. Balanced tool steel analysis and production in cold melt electric furnaces insure Merico steel's high tensile strength (165,000 lbs. PSI) and high yield point (140,000 lbs. PSI) . . . All reasons why Meridian Jacking Rods resist acute temperature changes, maintain their shape even on constant, extra-long pulls and give many years of satisfactory service.

Among Meridian Steel Jacking Rods' other advantages are these: Meridian rods and associated hardware are perfectly machined. Rods are available in either National Course or Acme thread in any pitch desired. Bars can be delivered in sizes up to 4½" round and as long as 22 ft.

For complete data on Meridian prestressing products, *write for free folder today!*

Meridian Steel Jacking Rods' Calculated Total Load

	1¾" RD.	2½" RD.	3½" RD.
WORKING FORCE	167,000 lbs.	358,000 lbs.	761,000 lbs.
JACKING FORCE	222,000 lbs.	477,000 lbs.	1,010,000 lbs.
ULTIMATE LOAD	278,000 lbs.	596,000 lbs.	1,270,000 lbs.

Meridian steels have successfully served American industry for over 30 years. They are LEAP *tested and approved.*

MERIDIAN STEEL COMPANY, INC.
1776 BROADWAY, NEW YORK 19, N. Y.

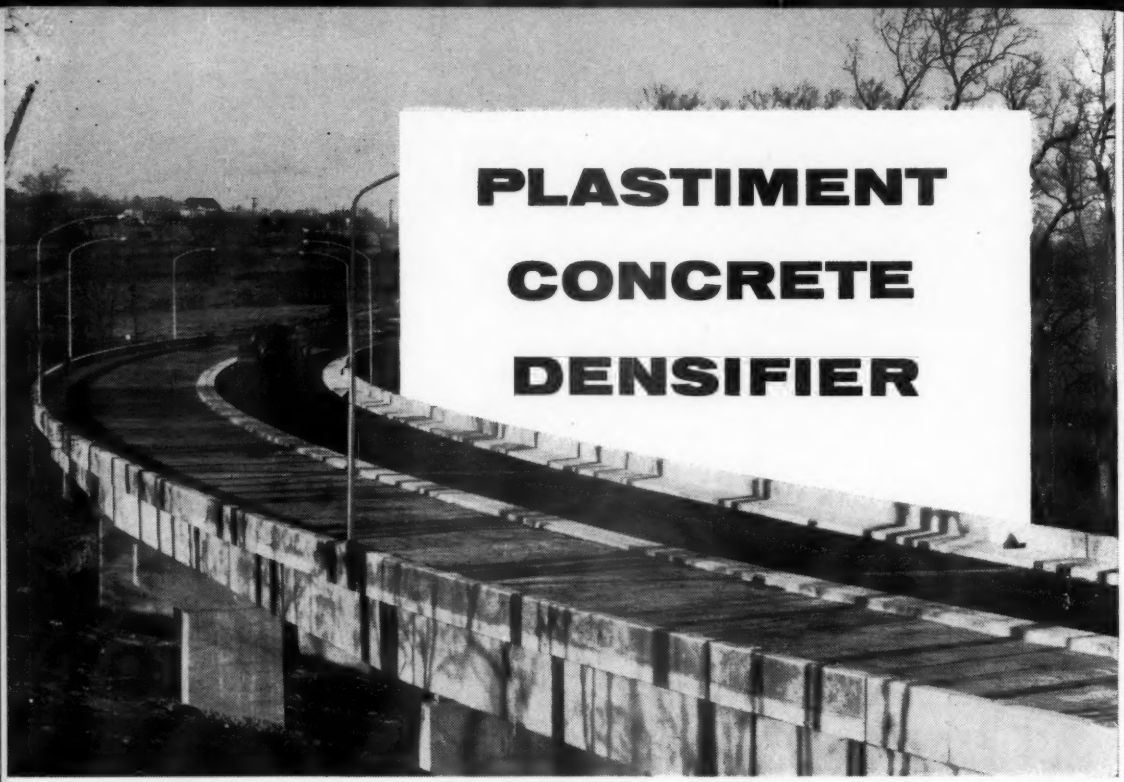
Meridian Steel Company, Inc.
1776 Broadway, New York 19, N. Y.
Please send me your free folder containing complete data on Meridian prestressing products. JP 128

My name_____

Title_____

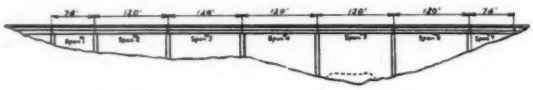
Company_____

City_____ Zone____ State____



PLASTIMENT CONCRETE DENSIFIER

Specified FOR PHILADELPHIA'S GORGAS LANE BRIDGE



Plastiment concrete in 7 foot deep beams is being revibrated before deck is placed.

This unusual monolithic prestressed beam and slab design resulted from alternate bids permitted by Philadelphia's progressive Department of Streets* . . . Savings of more than 20% over conventional steel design were passed on to the taxpayers.

Each 120 ft. long span, 34 ft. wide; including two traffic lanes, sidewalk, and half of the center median strip was concreted in one continuous 260-yard operation . . . Since 8-10 hours elapsed during placement, Plastiment was specified to control initial set. Plastiment provided these additional benefits: better compaction, greater density, and faster development of stressing strength.

Your clients will benefit from the better structural quality of Plastiment concrete . . . Specify Plastiment for your next job . . . Write for Bulletin PCD.

AD 26-7

*David M. Smallwood, Street Commissioner
Noel W. Willis, Chief Bridge Engineer

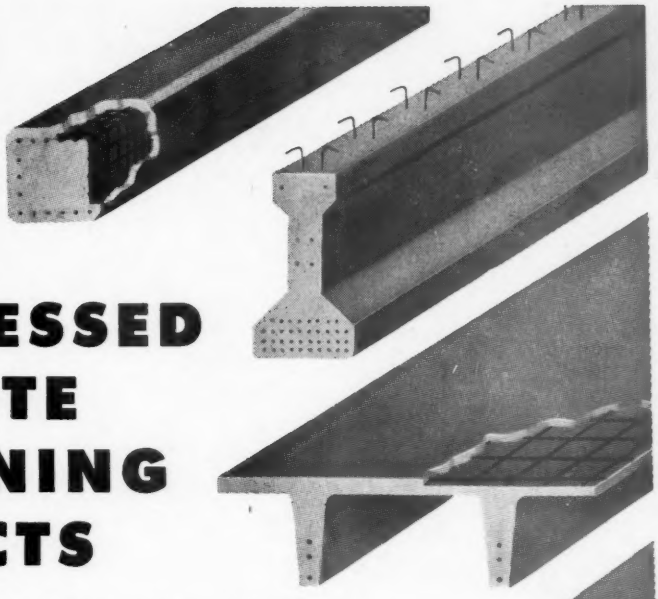
The Preload Company, Inc., New York City—Consulting Engineers
The Conduit & Foundation Corporation, Philadelphia—Contractor

SIKA CHEMICAL CORPORATION

PASSAIC, NEW JERSEY

DISTRICT OFFICES: BOSTON • CHICAGO • DALLAS • DETROIT • PHILADELPHIA • PITTSBURGH • SALT LAKE CITY • WASHINGTON • DEALERS IN PRINCIPAL CITIES—AFFILIATES AROUND THE WORLD

Sika

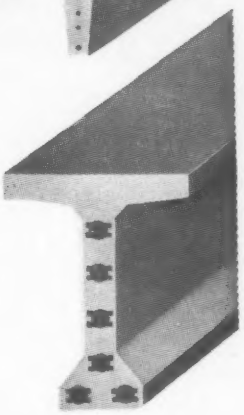


PRESTRESSED CONCRETE TENSIONING PRODUCTS

The answer to the need for faster, less costly construction lies in the use of prestressed concrete structures. CF&I Prestressed Concrete Strand and Wire are widely accepted by quality-conscious prestressing plants in the United States.

CF&I Prestressed Concrete Strand is particularly adaptable to pretensioning of prestressed concrete members. This 7-wire strand is stress relieved *after stranding*, which improves its elastic properties, flexibility and ease of handling. Its uniform physical properties and excellent bonding characteristics make it ideal for pretensioned applications. CF&I Prestressed Concrete Strand is made in accordance with ASTM A416-57T.

CF&I Prestressed Concrete Wire—for use in post-tensioned prestressed concrete structures—has excellent elastic and uniform physical properties. Due to the rigid quality controls, this wire when uncoiled will lie flat and straight for easy handling and working in the field. The quality of CF&I Prestressed Concrete Wire is ideal for Button type Anchorage and Wedge type Anchorage methods of post-tensioning.



Other CF&I Products For The Prestressed Concrete Industry

Clinton Welded Wire Fabric ASTM A185-56T
CF&I Concrete Reinforcing Bars and Rods ASTM A15-54T
CF&I Wire for Concrete Reinforcement ASTM A82-34
CF&I MB Spring Wire ASTM A227-47
Cal-Tie Wire
Wickwire Rope and Slings

6088-A

PRESTRESSED CONCRETE STRAND AND WIRE
THE COLORADO FUEL AND IRON CORPORATION

THE COLORADO FUEL AND IRON CORPORATION—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso Ft. Worth • Houston • Kansas City • Lincoln • Oklahoma City • Phoenix • Pueblo • Salt Lake City • Wichita • **PACIFIC COAST DIVISION**—Los Angeles • Oakland • Portland • San Francisco • San Leandro • Seattle • Spokane • **WICKWIRE SPENCER STEEL DIVISION**—Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia • **CF&I OFFICE IN CANADA:** Montreal • **CANADIAN REPRESENTATIVES AT:** Calgary • Edmonton • Vancouver • Winnipeg

Outriggers set and boom extended, this H-3 Hydrocrane places a precast beam through a church door at Manitowoc, Wis.

To give you a money-makin' edge . . .

SAFER LIFTS, CLOSER CONTROL WITH HYDROCRANE OUTRIGGERS

Four patented hydraulic outriggers, power-controlled from the crane cab, give Bucyrus-Erie Hydrocranes the stability of a big machine — the extra leverage needed for over-the-side lifts — the precise control that lets Hydrocranes handle precast concrete safer and faster.

These outriggers, adjustable both laterally and vertically, provide solid-as-a-rock stability, take the twists and strains off the truck chassis — eliminate spring and tire bounce. And the outriggers permit you to use an inexpensive, compact commercial truck mounting instead of a special mounting. With basic machine, you are within every state's weight and length limits — travel without a special permit. Traffic maneuvers are easy and you travel up to 50 mph on the road.

Your Bucyrus-Erie distributor wants to show you these stability and mobility features — and the many other advantages of the 12-ton H-5 and 5-ton H-3 Hydrocranes. Give him a call.

BUCYRUS-ERIE COMPANY • South Milwaukee, Wis.

278H58

Over 50% of Hydrocranes sold last year were repeat sales

I'd like more information on the

☐ H-5 ☐ H-3

Name _____

Company _____

Address _____

City _____ State _____

278H58

new performance standards for pre-stressed concrete

high strength in just seconds!

SMITH TURBINE-TYPE MIXER

This is the phenomenal new mixer which has averaged out *four times faster* than conventional types — WITH MUCH HIGHER STRENGTH RESULTS.

"LIVE MIX"

is the reason!

Mixing is in a doughnut-shaped drum. There is no "dead center" area. Blades set up a braiding action which breaks down centrifugal forces. Mixing is at a peripheral rate of *six hundred feet per minute!*

Data is available for both heavyweight and lightweight concrete mixes. Write for details.

THE T. L. SMITH COMPANY

Since 1900 the pioneer designer and foremost manufacturer of the world's finest mixers.

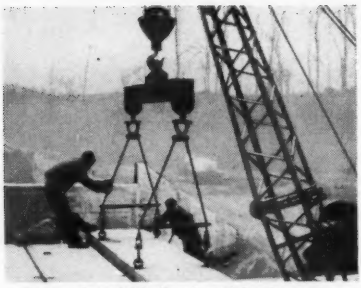
Milwaukee, Wisconsin • Lufkin, Texas

Affiliated with Essick Manufacturing Company • Los Angeles, Calif.

SMITH

A8-4045-1P

Use Richmond Inserts in Prestressed Concrete



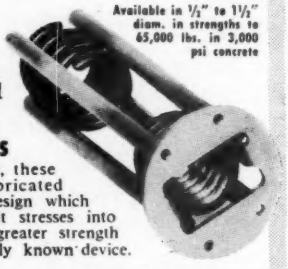
Placing of Amdek hollow box girders by means of *Richmond* Lifting Inserts with loads spread and equalized.

Versatility and Strength of Richmond Lifting, Anchoring and Fastening Inserts Assures Economy and Safety

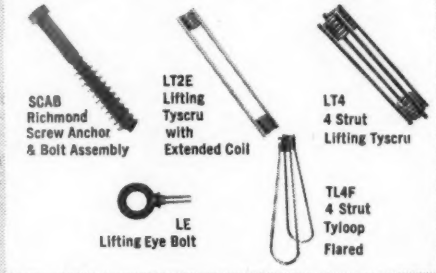
The ever increasing use of prestressed concrete has created a great need for a variety of special inserts for lifting, anchoring and fastening to prestressed concrete. Richmond has developed and tested a complete line of Lifting Inserts and Structural Concrete Inserts for prestressed columns, beams, girders, piles, etc. These inserts are designed with ample strength and for simple operation. Certified laboratory tests assure proper strength rating for efficient design and performance in prestressed concrete at usable strength.

New Richmond Structural Concrete Inserts

a recent addition, these inserts are prefabricated from a special design which distributes the bolt stresses into the concrete for greater strength than any previously known device.



Available in ⅜" to 1½" diam. in strengths to 65,000 lbs. in 3,000 psi concrete



The Richmond Data Book on Lifting Inserts and the new Richmond Bulletin on Structural Concrete Inserts give complete information about these and the many other Richmond Inserts specifically designed for safety and economy. Send for them — and for the current Richmond Handbook describing the full line of more than 400 Richmond-engineered products for the concrete construction industry. They are free for the asking. Write to: ——→

INSIST ON RICHMOND
....AND BE SURE
IT'S RICHMOND

TIME & LABOR SAVING CONSTRUCTION DEVICES FOR CONCRETE CONSTRUCTION

Richmond
SCREW ANCHOR CO., INC.
816-838 LIBERTY AVE., BROOKLYN 8, N.Y.
315 SOUTH FOURTH ST., ST. JOSEPH, MO.

JOURNAL

OF PRESTRESSED CONCRETE INSTITUTE

Vol. 3 December 1958 No. 3

OFFICERS AND DIRECTORS
1958-1959

Peter J. Verna, Jr.
President

Philip E. Balcomb
Vice President

Jacob O. Whitlock
Secretary-Treasurer

DIRECTORS

Douglas P. Cone
Randall M. Dubois
George W. Ford
Ben C. Gerwick, Jr.
J. Ashton Gray
R. O. Kasten
Prof. T. Y. Lin
John K. Zimmerman

EXECUTIVE SECRETARY
Martin P. Korn, M.ASCE

JOURNAL TECHNICAL EDITOR
Dr. A. M. Ozell

JOURNAL ASSOCIATE EDITOR
Douglas P. Cone

CHAIRMAN TECHNICAL ACTIVITIES COMMITTEE
Charles C. Zollman

•

The INSTITUTE is not responsible for any statements made or opinions expressed in its publications.

From the editor. . .

The fourth annual convention held in Chicago in September proved to be an exceedingly successful meeting. Many newcomers to the Institute were impressed by the close cooperation among the various producers, consultants and material suppliers. As usual, exchange of ideas in production, quality control, marketing and sales were invaluable experience to both the old and the new in the business. The field trip to the Illinois Toll-Road and to the laboratories of Portland Cement Association added a great deal to the success of the convention. The General Arrangements Committee of the Convention is to be congratulated for its work well done.

Reports on work being performed in Russia and northern Europe published in this issue will make apparent once again the endless horizons of prestressed concrete.

The paper on "Fire Ratings and Building Codes" was presented by Mr. E. N. Searl at the convention and is published in this issue since the topic is of utmost importance to those in the prestressing business.

The **JOURNAL** is published quarterly by the **PRESTRESSED CONCRETE INSTITUTE, INC.,** 425 N. E. Fifth Street, Boca Raton, Florida. **TECHNICAL EDITOR:** Dr. A. M. Ozell, University of Florida, Gainesville, Florida. **ASSOCIATE EDITOR:** Douglas P. Cone, P. O. Box 11476, Tampa, Florida. **ADVERTISING, SUBSCRIPTION** and **PUBLICATION OFFICE:** 3132 N. E. Ninth Street, Fort Lauderdale, Florida. **DISTRIBUTION:** Available without cost to all members of the Prestressed Concrete Institute. **SUBSCRIPTION PRICES:** $6.00 per year for four issues. Single copy price: $2.00. For subscriptions outside the continental United States, add 20% to cover handling and mailing. Editorial contributions to the **JOURNAL** are welcomed, but publication cannot be guaranteed. All manuscripts should be submitted in duplicate and will be reviewed by the Technical Editor prior to publication. Advertisements of products, services and materials allied to the prestressed concrete industry are acceptable. Inquiries concerning advertising, and subscriptions should be directed to the Publication Office.

Copyright by the **PRESTRESSED CONCRETE INSTITUTE, INC.,** 1958.

A Report on the International Congress on Prestressed Concrete in Berlin, 1958

prestressed concrete in northern europe

Ben C. Gerwick, Jr., of Ben C. Gerwick, Inc., San Francisco, Cal., who is co-author of this article with Prof. T. Y. Lin, University of California.

The International Congress on Prestressed Concrete, which was held in Berlin in May of this year, afforded an outstanding opportunity for American engineers to learn of European practice and to see some notable and unusual structures of prestressed concrete.

The architects and architect-engineers throughout the world and especially in Europe have found that they have in prestressed concrete a material which gives them great freedom of design and expression. They are creating numerous unique and beautiful structures. In addition to the exposition halls which have always been a favorite structure in which to express new concepts, there is a decided effort to make typical utilitarian structures aesthetically attractive through the medium of prestressed concrete. This extends to such structures as industrial buildings, elevated water storage tanks, television towers, railway stations, railroad and highway bridges, and transmission towers.

The methods of utilizing prestressed concrete varies widely from country to country. In Germany, for example, most of the structures are cast-in-place post-tensioned structures, whereas in many other countries, plant produced precast prestressed units are more extensively used. One general conclusion can be fairly made, however, and that is that prestressed concrete is the dominant or primary structural material for most types of structures now being built in Northern Europe.

Shortages of labor, the high price of aggregates in many areas, and shortages of steel, combined with the comparatively low price for high strength steel for prestressing, make prestressed concrete economically attractive for practically all types of structures.

But these economic factors, while of great initial importance in the growth of prestressed concrete are secondary in importance to the structural and architectural properties, which make it possible to build more efficiently, effectively, and beautifully.

Berlin was an ideal choice for the International Congress, for not only does it symbolize the meeting place of a divided world, but also its enormous reconstruction program is being carried out with prestressed concrete as the primary material.

The Congress was held in the Benjamin Franklin Congress Hall, a gift of the United States and West German governments, which is a beautiful prestressed thin shell structure. This was an International Congress with 1200 delegates from some 40 countries, from all parts of the world.

It was astounding to see how widespread and extensive use was being made of prestressed concrete in some of the so-called undeveloped countries of the world, using unskilled indigenous labor to construct outstanding structures in remote locations.

This was the Third International Congress of the Federation Internationale de la Precontrainte. There were four sessions or themes.

The first session was entitled "Developments in Design Methods." Subjects treated most extensively included the following:

(a) The influence of biaxial stress on concrete strength. The increase in strength ranges up to 50% under biaxial compression and this is of importance with concrete slabs, highways and runways, and shells.

(b) Flexural strength — Formulae now have been developed which give agreement with test values on the entire range from under-reinforced to over-reinforced sections.

(c) Shear strength — It was generally agreed that shear failure is produced by the combined influence of moment and shearing force. It was the general consensus that shear strength is not yet completely understood because of the many other influencing factors, such as shape of cross-section, degree of prestressing, shear span, type of load and support, web reinforcement, strength of concrete, and the strength under combined stresses.

(d) Torsional strength. While the torsional strength of prestressed concrete is high, when the first cracks do appear, the failure is sudden, unless additional mild steel reinforcement has been provided.

(e) Shells. Prestressing makes it possible to reduce the bending stresses caused by edge interferences in shells.

The Second Session was entitled "Progress in Site Techniques." Particular emphasis was given to grouting and it was felt that improvement of the quality of grouting is still an urgent problem for post-tensioned concrete. The main objects of grouting were restated to be:

Figure 1: The Congress Hall of West Berlin has a prestressed concrete shell roof.

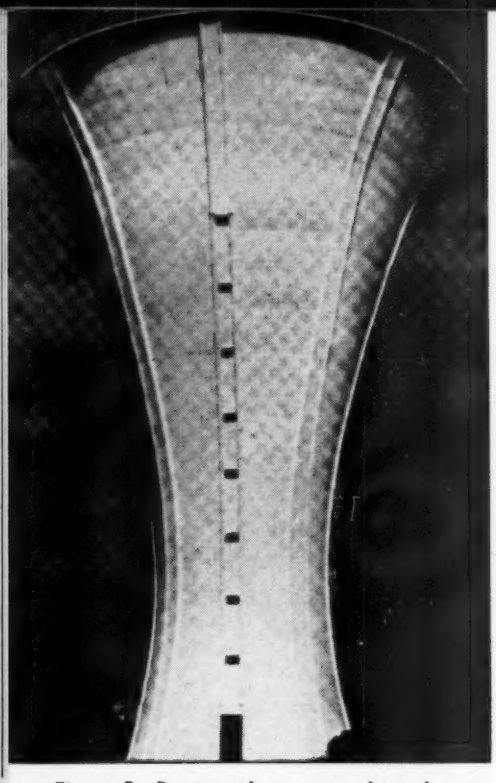
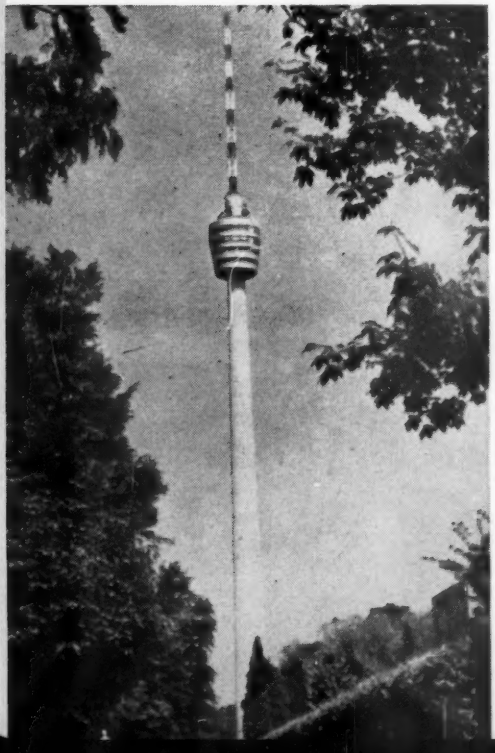


Figure 2: Prestressed concrete elevated water reservoir, Corgenon, France.

•

Figure 3: The Stuttgart Tower designed by Dr. F. Leonhardt.



1. To protect the prestressing steel from corrosion.
2. To increase the ultimate strength by providing bond.
3. To increase the shear resistance.

The biggest problem seems to be that of insuring that the ducts are completely filled with grout. There was a wide variance in opinions and practices in different countries as to how to accomplish this and particularly as to the grout mix to be used, but all agreed on a low water-cement ratio. And in cold countries, the grout must be frost-proof for several days after grouting, and this has been somewhat difficult to insure in practice. The personal factor, the need for trained and experienced technicians in the field, was felt to be of major importance. An international committee is being set up by the International Federation to further investigate this problem of grouting. To eliminate the problem of grouting in ducts, some structures are making use of external post-tensioning cables, (placed just outside the web) which are then bonded to the web and protected by concrete encasement and mild steel stirrups.

The second phase of this session dealt with friction in post-tensioned practice, and emphasized the many components that make up the total friction in a post-tensioning system. The "wobble" effect, due to small but numerous changes in alignment in the duct, was discussed as well as means of minimizing it.

Because of the important effect of friction, and difficulties of exact calculation, it was recommended that the cables should not be subject to too great curvatures and particularly not too much curvature in two dimensions.

New anchorage devices were discussed, and of particular interest were the "blind" anchorages with capacities up to 1400 tons each used to prestress dams to the bedrock.

Other anchorages are based on the use of a steel tube or sleeve, through which the wires are drawn and splayed, and the tube then filled with high early strength grout.

The properties of high strength steel wire were discussed with particular emphasis on long term relaxation, and an extensive investigation into defects in steel wire, and their causes.

Session III was on the subject of "Progress in the Manufacture of Factory-made Precast

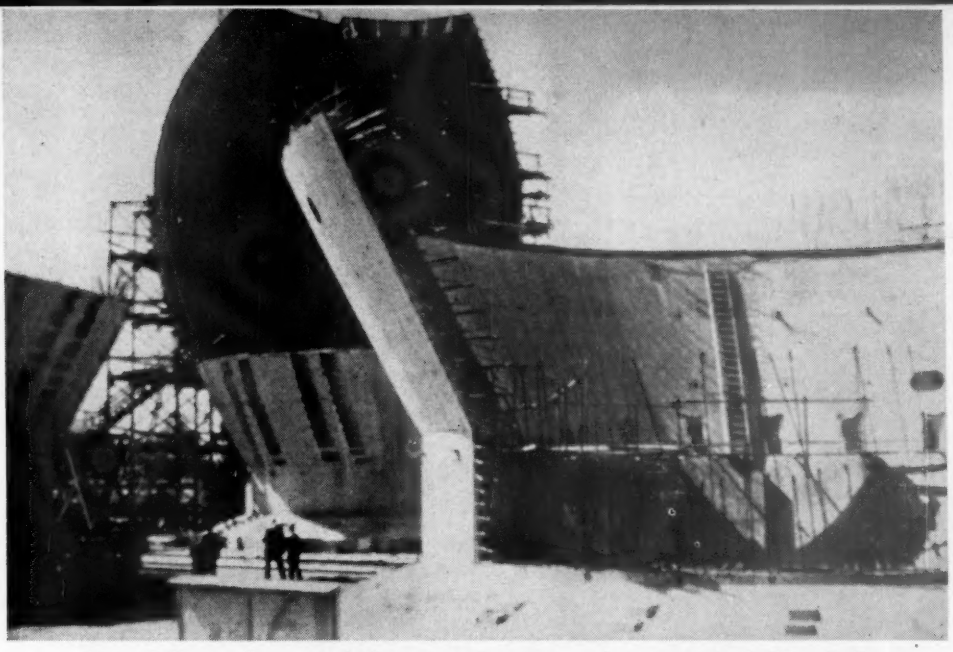


Figure 4: Sewage digester tank of prestressed concrete, under construction in West Berlin

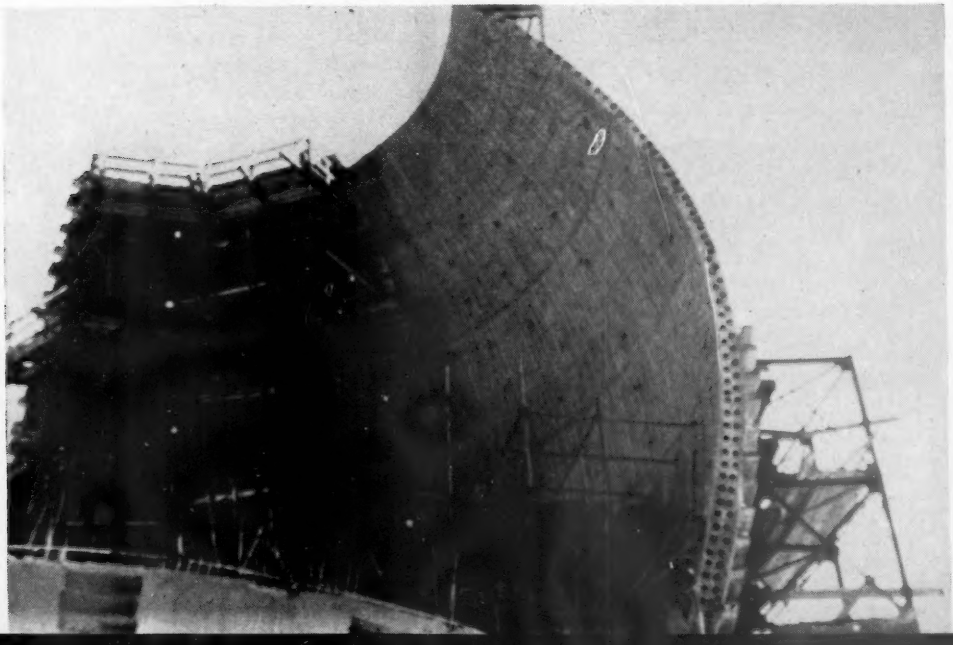
Prestressed Concrete Units and in Their Use and Assembly on the Site." It was the general opinion of many that there was a growing trend to the use of factory made units.

Of great interest were the Russian papers and film on continuous prestressing in large scale factory production.

Several papers gave the results of bond tests on pretensioned wire, made on actual factory-produced units, as opposed to the usual reports available in which the tests were made on laboratory produced units. The advantage of strand for development of bond was emphasized as well as the need for high strength concrete to develop adequate bond with a minimum transmission length.

Many papers discussed the manufacture and utilization of prestressed bridge girders. Of particular interest was the use of short

Figure 5: Sewage digester tank of prestressed concrete under construction in West Berlin



precast segments, erected on temporary supports and joined by welding and cast-in-place plugs, and then post-tensioned, thus forming long span structures. Composite construction with precast prestressed beams and cast-in-place slab appears to be gaining in use. The report from the Netherlands was of great importance. It was a report and analysis of the several means used to gain continuity over piers or supports, when joining precast members.

It was interesting to note that the reports on the use of prestressed concrete piles showed that European practice is based on and following after the schemes developed and extensively used here in the United States. In England, prestressed concrete piles are generally replacing conventionally reinforced precast concrete piles.

India reported large-scale factory production of plant manufactured standard railway bridge girders of 60-ft. span as well as large orders for poles, and the rapidly growing use of precast elements in building construction.

Assembly of precast units into structural framework of large buildings, with particular reference to obtaining full moment connections, formed the subject of many papers, and examples were given of several interesting and beautiful structures.

Session IV was a report on "Structures Executed Since the Previous Congress in 1955, and Embodying Important Developments in Design and Construction." These were so numerous as to require two sessions of the Congress. This was a truly remarkable presentation and most impressive in the scope of structures, their size, the boldness of concept and general excellence of execution, and particularly their geographically widespread use. Particularly interesting were the following, although all the papers in this session were of great interest.

a) Exposition Hall in Belgrade, Yugoslavia, where a dome was formed of delicate ribs alternating with open spaces to form a beautiful pattern.
b) The bridge across the Rhine at Dusseldorf where precast girders weighing 500 tons were transported and placed.
c) Exposition Palace in Paris where precast units were connected to form a thin shell dome with a span of 730 feet.
d) Bridges constructed in France, and in Africa, by French engineers, obtaining long span structures for very heavy loadings, often both rail and highway, using a minimum of construction equipment.
e) Elevated water storage tanks in Spain, France, and particularly one from Sweden, where the tank itself was cast at ground level, then jacked up progressively as the stem was constructed in sections under the tank.

The field trip in Berlin during the conference was of great interest both for inspection of prestressed concrete and from a general interest viewpoint.

The highlight in prestressed concrete was unquestionably the sewage digestion tanks, beautiful double-curved prestressed thin-shell structures like huge pears, standing on their ends. Of considerable interest also was a major bridge being constructed by the progressive cantilever method, but unfortunately only the main pier and one cantilever section had been completed at the time of our visit.

The general or political aspects were the magnitude of the destruction that had been hurled on Berlin, the energy which West Berlin was displaying in reconstruction, (primarily in prestressed concrete), and a visit to the Russian War Memorial in East Berlin, which, forgetting for the moment the political overtones, was most impressive.

During the Congress sessions, Secretary of State John Foster Dulles paid a visit to West Berlin which was a silent but effective answer to the recent imposition of a new blockade on West Berlin; the East German government having drastically raised the tolls on all products transported to West Berlin. Since West Berlin is an island, all coal, cement, aggregates, steel, industrial goods, and much food moves to West Berlin from West Germany by barges and boats on the canals, and the tripling of tolls is a very insidious and effective form of blockade. Secretary Dulles looked in on the Congress; he was greeted with an ovation by these assembled delegates from many parts of the world.

One of the most rewarding aspects of this Congress was the opportunity to meet and talk with engineers, contractors, manufacturers, professors, and others associated with prestressed concrete, coming from diverse countries but all vitally interested in the subject.

Figure 6: Approach to the Moscow River Bridge makes use of precast, post-tensioned units of 72 ft. span.

In the discussions it was pointed out that precast units can be worked into beautiful architectural forms, even complex ones, and the examples of Nervi in Italy were quoted. Standardization of manufacture should be coupled with imagination in use.

Another subject discussed was the effect of radiation on prestressing steel and on concrete, particularly when used for nuclear reactors as it is being used in Europe, but these effects are not felt to be as important as those of heat.

The United States was well represented at the conference, with many of our representatives taking part in the presentation of papers, and the conduct and the organization of the Conference. Through the Prestressed Concrete Institute, the U.S.A. is a member of International Federation and is represented on its governing bodies.

In trips elsewhere in Northern Europe, the most impressive items in prestressed concrete were the colorful building wall units being produced in Denmark; the multitude of comparatively utilitarian elements such as fence posts, guard rails, poles, etc. also used extensively in Denmark; the high quality of the factory made structural elements in Sweden and their utilization in a wide variety of structures including conveyor bridges and multi-story buildings, the practically universal use of prestressed concrete for highway overpasses and bridges up to 350-ft. in span in Germany, as well as prestressed spiral staircases, prestressed light and transmission poles, and prestressed ties; and of course the imaginative and daring use of prestressed concrete at the Brussels Exposition, which is the subject of a paper all by itself.

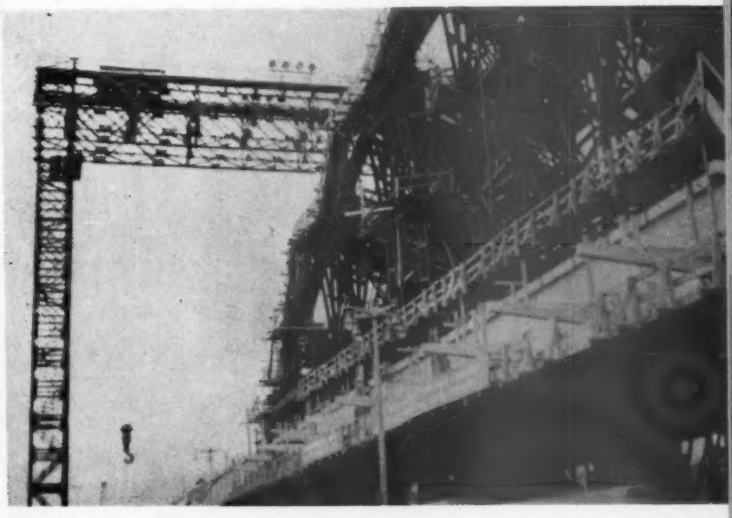


Figure 7: Main span of the Moscow River Bridge. Each unit, weighing 5500 tons, was assembled on shore then floated into position. Units are fabricated of precast elements post-tensioned together.

ERRATA TO PROCEEDINGS OF WORLD CONFERENCE ON PRESTRESSED CONCRETE

The following errata pertain to the Proceedings of the World Conference on Prestressed Concrete, July 1957.

1. **Paper A16 — Information on Prestressed Bridges in USSR (Discussion) by I. Barenboim.** On pg. A16-1, first column, line 14. Change "5½ years to 5½ months."

2. **Paper A33 — Diagonal Tension in Prestressed Concrete Beams by C. J. Bernhardt.** The following tables should be added to the paper:
   Table 1 I-Beams
   Table 2 Beams with Rectangular Cross-section.

Table 1 I-Beams

Beam	σu bFK psi	K_T psi	c/c stirrups inches	F_a stirrups sq.inches/ft	Q_R ton	Q_B ton	$\frac{Q_R}{b_0 h}\frac{1}{K_T}$	$\frac{Q_B}{b_0 h}\frac{1}{K_T}$ observed	$\frac{Q_B}{Q_R}$	$\frac{\alpha}{g_R}$
1	2140	9000	00	0,000	11,7	12,6	0,063	0,068	1,08	0,65
2	2320	7850	7	0,077	11,7	15,0	0,072	0,093	1,29	0,65
3	2410	7900	7	0,077	12,7	16,7	0,080	0,103	1,31	0,70
4	2210	7900	5	0,107	11,7	14,4	0,072	0,089	1,23	0,65
5	2220	7900	4	0,133	11,7	14,7	0,074	0,091	1,26	0,65
6	2390	7500	3	0,176	13,7	21,5	0,089	0,140	1,57	0,76
7	2360	7300	2	0,267	12,7	17,7	0,085	0,119	1,40	0,70
	2300	7900					0,076			0,68
8	1000	6800	00	0,000	9,6	9,6	0,069	0,069	1,00	0,53
9	1280	8750	7	0,077	11,7	11,7	0,065	0,065	1,00	0,65
10	1160	8400	6	0,089	10,6	14,5	0,061	0,084	1,37	0,59
11	1090	9000	5	0,107	9,6	13,2	0,052	0,072	1,38	0,53
12	1260	8400	4	0,133	10,6	16,0	0,061	0,093	1,51	0,59
13	1270	9100	3	0,176	11,6	15,7	0,062	0,085	1,35	0,65
14	1270	7200	2	0,267	11,1	16,7	0,075	0,113	1,50	0,62
	1190	8200					0,064			0,59

Table 2 Beams with Rectangular Cross-section

Beam	σu bFK psi	K_T psi	c/c stirrups inches	F_a stirrups sq.inches/ft	Q_R ton	Q_B ton	$\frac{Q_R}{b_0 h}\frac{1}{K_T}$	$\frac{Q_B}{b_0 h}\frac{1}{K_T}$ observed	$\frac{Q_B}{Q_R}$	
15	1850	6200	00	0	7,3	9,1	0,060	0,075	1,25	
16	1850	6200	4	0,133	7,6	9,3	0,062	0,076	1,22	
17	1850	6200	4	0,133	9,65	9,65	0,079	0,079	1,00	
18	850	5800	00	0	11,2	11,2	0,098	0,098	1,00	
19	780	4700	4	0,133	10,6	10,6	0,114	0,114	1,00	

By EDWIN N. SEARL

•

PRESENTED AT THE FOURTH
ANNUAL CONVENTION OF THE
PRESTRESSED CONCRETE INSTITUTE,
SEPTEMBER 25, 1958

Fire Ratings and Building Codes

(Editor's Note: We are pleased to publish this paper because of its high educational value. It should give the manufacturer of prestressed products and his sales staff, a better understanding of the various requirements of fire ratings applicable to building codes.)

Your Program Committee has asked me to discuss fire retardant ratings, building code provisions and insurance rates. These are three distinct subjects. They do have a common denominator, namely, "What will happen in case of fire?"

The easiest way to learn this is to study what has happened in actual fires. This is also an easy way to pick up some interesting — and somewhat startling — information.

For example, you can get first-hand information from "on the spot" witnesses that lubricating oil is more dangerous, will ignite more easily and will burn more intensely than gasoline. After some careful

checking, you may learn that the lubricating oil was on the first floor and in the area where the fire started. The gasoline may have been on the third floor in an area untouched by the fire; in fact, the gasoline may not have felt any warmth at all from the fire.

Another witness may have learned from first-hand experience that aluminum foil nailed to a wood panel door will stop a fire dead in its tracks. He knows that this is so because he saw the evidence and, furthermore, he will testify that the fire was so intense that concrete spalled and steel buckled. This witness may even have a theory to match his "facts" and may go into detail as to the unusual chemical activity of metallic aluminum or the reflective qualities of a shiny surface as compared with a dull finish. A little independent research may develop, as a matter of pure coincidence, that a 4-11 call by the Fire Department brought out a virtual army of fire fighters who made a stand with master fog streams at a line somewhat in advance of the foil covered door.

In other words, field experience requires an investigation by competent observers to find out what **really** happened in that fire.

Evaluation of fire experience is **not** an exact science. Fires themselves do not follow the same pattern. One fire may smolder for hours undetected before it bursts into the open. Another may "take off" with unbelievable speed, causing tenants to flee to avoid being trapped. The temperatures involved in one fire may be relatively moderate and in another case may run quite high. The intensity will be affected not only by the "fire loading", that is, by the B.T.U. of fuel available per square foot of floor area but also by the physical arrangement of the fuel. That is, is it excelsior or is it sawdust? Is it unbaled waste paper or is it rolls of newsprint? The spread of fire will be affected by the dispersal. That is, is it congested storage with narrow aisles and high piling or is it simply display stock of sample items? Was the fire department prompt in arriving with adequate manning, equipment and water supply or was the department told that the fire was on North Main Street instead of South Main Street and did the firemen have to find the fire by watching for it on the horizon?

It takes time to develop field experience. Your convention, assembled here in Chicago, represents many square feet and many dollars of prestressed concrete construction in all portions of the country. Yet the field experience is sketchy. Why is that? It is simply that, despite a fire loss last year in excess of one billion dollars, the chances that a particular building will experience a fire continue to be, fortunately, quite low. Think of your own personal experience. The house that you live in. The school you attended. The plant that you worked in. Most buildings never experience a serious fire. The field experience of those buildings which have never experienced a fire may give the insurance company a breathing spell — and Heaven knows at this time they really need it — but it gives absolutely no information as to what might happen if the structures were involved in a serious fire.

The obvious answer is that if your industry is relatively young and if you do not have the patience to wait around for the next thirty years for the development of credible field experience — possibly turning out an inferior product fire-wise for a goodly portion of that time — the obvious answer is to develop some experience by tests under controlled conditions. Others have done so. And in developing evidence to show others how good their product might be, they have many times found out for themselves how to develop a better product for the benefit of all concerned.

In talking about fire tests, we hear such phrases as "fire retardant ratings", "one hour classification", "flame spread of 50", etc. If we are going to use these phrases, we should know what they mean. Possibly these terms were discussed yesterday during the field trip to the Portland Cement Association's new laboratories.

Two types of standard fire tests are used in evaluation of structural materials. They are (1) Fire Retardant Tests, which serve as the basis for fire resistance ratings and which express retardance in terms of hours, and (2) the Fire Hazard Classification Test, which determines the hazard of the material in comparison with other structural material.

A fire retardant test determines how a fire may be confined or held back or simply

how fire can be endured by the structure. This type of test is conducted to test floor assemblies, ceilings, roofs, partitions, fire doors, columns or similar assemblies. The sample is built as a part of the furnace or, in the case of a column, may be simply installed inside the furnace. The temperature inside the furnace is controlled to meet standard requirements and is measured during the test to see that it does not vary appreciably from these requirements.

To obtain a fire retardant rating a sample must:

1. Sustain its design load during the specified period without collapse.
2. Prevent the passage of flame or hot gases.
3. Must in many instances be capable of sustaining twice its design load after the conclusion of the fire test.
4. Must avoid a temperature increase on the unexposed surface in excess of 250 degrees Fahrenheit.
5. When a hose stream is specified, the sample must be capable of withstanding erosion by a hose stream of specified intensity after the fire test and without collapse.

After the assembly has retarded or resisted fire successfully for the specified period, the assembly may by then have been, for all practical purposes, destroyed. It may be worthless or it may be on fire and may continue to burn. Also, these ratings are based upon ultimate performance. You are all familiar with factors of safety used generally in design work. There is nothing comparable to this in fire retardant ratings. If an assembly stands up for 60 minutes and fails at 61 minutes, it is classed as a one hour assembly.

While information as to fire resistance ratings is available from many sources, the best single source is the green colored booklet issued by the National Board of Fire Underwriters. under the caption "Fire Resistance Ratings."

The second type of fire test is the Fire Hazard Classification Test, sometimes called the Tunnel Test. In this test a sample 20" wide by 25' long is installed as the roof of a tunnel-like chamber which has a gas jet at one end and a flue at the other. A cement-asbestos decking is used as the zero point on this scale and a red oak decking is burned under controlled conditions to establish an arbitrary 100 points on the same scale. Each sample to be evaluated is subjected to the gas jet under identical conditions. If it burns twice as fast as the standard red oak, the sample is classed as having a flame spread of 200; if it burns half as fast, it is classed as having a flame spread of 50.

The Fire Hazard Classification Test was originally intended to evaluate those materials which have burning rates in the quick burning or hazardous range. It is now, however, commonly used for those materials which are nearly noncombustible. In fact, a definition used commonly for a homogeneous material is that a structural material having a flame spread of 25 or less with no evidence of continued progressive combustion may be classed as noncombustible.

A good source for flame spread listings, evaluated in this manner, is the Fire Protection Equipment List of Underwriters' Laboratories.

Occasionally, there is loose and confusing use of such terms as "fire-resistive", "flame-retardant", "flame-proof", etc. "Fire-resistive" has a very definite and sometimes statutory meaning in terms of a 2 or 3 or 4 hour fire retardant rating. "Flame-retardant" usually refers to combustible materials which have been subjected to treatment so as to prevent or retard ignition or the spread of fire under the conditions of use. "Flame-proof" may mean treatment such that the material will not readily ignite and will not propagate flame under specified test conditions. These terms need further amplification by the people using them in order that they may have a definite significance.

How is this information used in building codes? Possibly, we should stop first and consider why there are building codes.

Not too many years ago, an archeologist uncovered a black obelisk in the Near East and deciphered from it the now famous Code of Hammurabi. A portion of the inscription reads as follows:

> "In the case of collapse of a defective building, the architect is put to death if the owner is killed by the accident; and the architect's son if the son of the owner loses his life."

This was the law of the land in ancient Babylon, about 2100 years B.C. It is one

of the earliest building codes, was short, to the point and involved not only a performance standard (the building either stood up; or it collapsed and caused a fatality) but included also a graduated scale of penalties — well, anyway, two penalties.

In the 14th century, the city of London enacted an ordinance requiring that chimneys be built of stone, tile or plaster and prohibited the use of timber for this purpose. Our own early pioneers sometimes used log chimneys and trusted to the Lord — and to a heavy plastering of mud — to keep their cabins from burning up. G.I.'s who fought in Korea tell us that now, in the middle of the 20th century, there exist peoples who build chimneys out of wood — and who sometimes burn up as a result.

The purpose of building codes is still public safety as it was in the time of Hammurabi and in 14th century London. To put it simply, a building code is a set of rules to keep people from getting hurt. I am not a regulatory official myself but I believe most building commissioners will agree with that.

Earlier codes in this country were in some instances a set of rules telling how buildings might be built. Present day model codes are essentially performance standards, that is, they prescribe limitations upon height and area based upon such factors as the nature of the occupancy, the fire resistance rating of the structural material, etc. When buildings are several stories high so that fires cannot be fought from the ground, a definite fire retardance is necessary so that fire fighters can make a stand with reasonable assurance that the floor or roof will not collapse beneath them. Codes provide flame spread limitations upon interior finish materials such as wall panelings or acoustic ceilings or floor surfacing so as to minimize the possibility of trapping people so that they cannot escape because of rapid spread. Fire walls are required to protect people (and property) from the hazards presented by their neighbors.

It is possible to relate code requirements to the anticipated fire load of the occupancy. For example, 10 pounds of combustibles per square foot can be related to a one hour fire of specified intensity. Similarly, 30 pounds of combustibles might require three hour fire retardant floors or roof. The danger here is that the end product may be a single purpose building, one that may be suitable for its first occupant but not adequately fire proofed for successive tenants. Some occupancies, such as warehouses or wholesale properties, may have such a heavy loading of potential fuel that three or four hour retardance by itself may be insufficient and sprinkler protection may be required under the code in addition to the specified fire retardance of the structure.

By setting up performance standards, by specifying legal requirements in terms of fire resistance ratings, flame spread ratings, etc., regulatory officials do not have to determine by looking, sniffing or passing their hands over a material whether it is suitable or not. Developers of a new material or of a new theory of design are in a position to present acceptable engineering evidence and what looks like a closed door in front of them swings open. No building code can remain static. Performance standards can help to keep a code effective. However, periodic review is also necessary.

At the present time, much construction is under way in outlying or suburban areas. Industrial plants, shopping centers, housing developments all are seeking room for growth. Many times the building codes or regulations in these areas are weak or nonexistent. This is often coupled with small town fire departments and water supplies which are obviously inadequate for the responsibilities thrust upon them. Faced with this combination, it would not be sound judgment to take advantage of the absence of building code requirements by employing designs unsuitable for the safety of the particular project.

What about fire insurance rates? The Chairman mentioned that the organization I am with serves in an advisory capacity to a number of fire insurance rating organizations in the midwest. Because of this, I can speak from an intimate understanding of the factors involved in determining fire insurance rates. Many of you are from the East Coast or the West or from the South where details of rating practices may differ in some respects from those in this area. However, these are details. The problems faced by the fire insurance rating bureaus are much the same countrywide.

It would be simple to establish a fire insurance rate of $1.00 and apply that across

the board to all properties. That is, it would be simple for about the first ten seconds. Right away, we would find that the $1.00 was much too high for many risks and would be obviously inequitable. The same $1.00 rate would be "Today's Big Bargain" for many other properties, except that an insurance company would go bankrupt by paying out more than it took in on higher hazard properties. So, rates would need to be adjusted upward for those properties where, for example, painting and dipping operations were poorly safeguarded and adjusted downward when these hazards were well protected or, perhaps, did not exist. Similarly, the property located adjacent to a large lumberyard would carry a higher rate and one protected with an automatic sprinkler system would receive a substantial credit for this protection.

In other words, we would be getting into a procedure of schedule rating whereby properties with similar characteristics and hazards would be accorded similar rates while those with relatively greater or less hazards would have their fire insurance rates adjusted accordingly.

It is always a little dangerous to discuss fire insurance rating with construction people because all too often they are so interested in the details of construction that they fail to remember that the occupancy, the special hazards, the protection (both private and public), the exposure situation, all may have a terrific impact on an individual rate.

What structural features are important in connection with establishing a fire insurance rate? Well, first, does the construction tend to spread the fire so the entire building may become involved? Are stair shafts, elevators, etc. cut off at each floor so as to limit the extent of involvement? Are special hazards partitioned off so that a fire originating in a hot spot will be confined therein? Are the basic structural elements protected so as to be able to withstand the fire which might be anticipated? What is the fire retardant rating of the walls, floors, partitions and roof? How much damage may result or, to put this in reverse, how much salvage might be expected? It is the amount of salvage after a fire which determines whether the structural arrangement has any value to an insurance company. A structure which became a 90% loss in 15 minutes and a structure which became a 90% loss after 15 hours, despite efforts to save it, are both 90% losses although possibly the insurance underwriter may suffer helplessly a little longer in connection with the second risk.

How can fire test information help in establishing a fire insurance rate? In administering a building code, a regulatory official wants to know whether the tenants will have an opportunity to escape and whether the fire will endanger neighboring properties, that is, whether the construction will assist in safeguarding both life and property. In connection with fire insurance rating, an underwriter wants to know whether the construction will assist in reducing the property damage of the structure which is directly involved. He is interested in some of the same test data but he may study it a little differently. The fire retardant rating is of prime importance to him. He is also vitally interested in the damage suffered by the assembly during the test. Many materials are so badly damaged as to be a total insurance loss even though classed as successful in achieving a particular fire retardant rating.

The Prestressed Concrete Institute deserves credit for its fire test program. In this program, the industry is facing up to its responsibility by making available information as to fire performance. The basic information being developed is going to be invaluable in the development of better products and, in this way, assist in the expansion of the industry from highway and bridge use, where fire performance has not been a factor, to widespread acceptance in building construction, where fire performance is an important factor. The test program is developing information as to the amount of concrete fireproofing cover needed to protect prestressed strands, the type of concrete aggregate less likely to spall, most advantageous densities of concrete, information as to the behaviour of reinforcing cables under fire conditions, the need for interconnection of slabs with each other and with structural supports, the bearing needed — not simply from a load standpoint — but to prevent the slab slipping off the bearing supports because of deflection or distortion under heat.

One of the problems facing regulatory

officials, and also fire insurance rating organizations, in the use of fire test data is the identification of slabs used in the field as being comparable to the designs which may have performed very well in a laboratory test. You all know, better than I do, that slabs which may look alike to an untrained eye may have been built to quite different specifications. The simplest answer to this problem is the use of factory inspection service on behalf of a competent testing agency. Labeling in this way certifies in a manner which no one will question.

To an outsider, the activities of the technical committees of the Institute, particularly that concerned with your fire test program, is one of the outstanding contributions that the Institute can make on behalf of its members. I am confident that this group will master the technical problems which confront them, as other associations have done, and will come up with the answers which are so badly needed.

Here again is definite proof that by cooperative effort a problem common to all can be mastered for the benefit of all. Even a mess of freckles can become a beautiful coat of tan if they all get close enough together.

■ ■ ■ ■ ■ ■ ■ ■ ■

What is P. C. I.?

By J. REX FARRIOR, JR.
Legal Counselor for P. C. I.
Tampa, Florida

P.C.I. is legally known as Prestressed Concrete Institute, Inc., a corporation not for profit organized and existing under the statutes of Florida, Chapter 617. The Institute is legally recognized as a scientific, charitable and benevolent association.

The original charter was approved by the Circuit Court at Tampa, Florida, on June 18, 1954. Officially, the object of the Institute is the formation of an association of manufacturers of prestressed concrete and of persons and companies in allied or related industries for the mutual exchange of information and ideas; and generally to do anything beneficial for its members and the prestressing business which does not violate the laws of Florida or the United States.

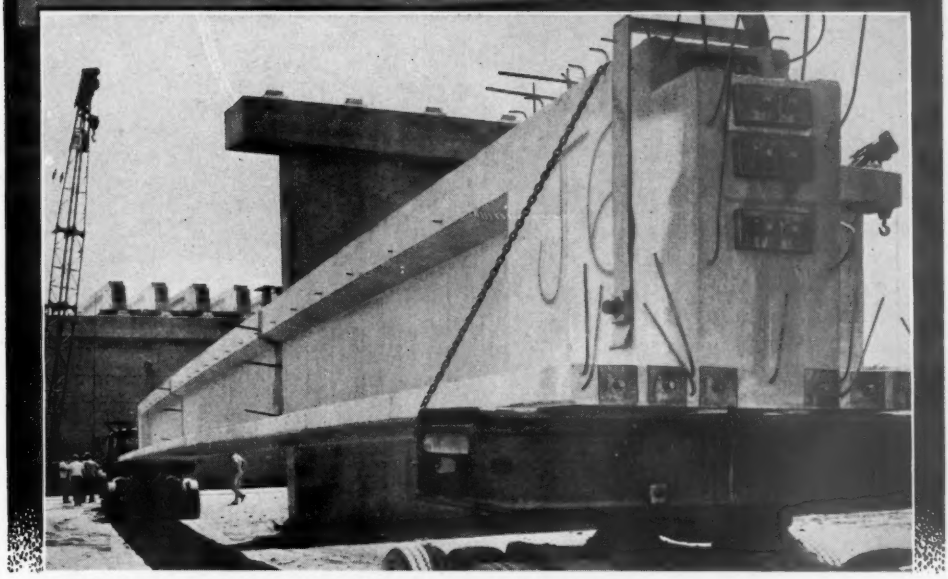
The charter provides for seven classes of members: Active, for prestressed manufacturers; Associate, for related businesses; Professional, for architects and engineers; Affiliate, for supervisory and technical employees, non-graduate; Junior, for architects and engineers in training; Student, for students enrolled in accredited architectural and engineering colleges, and Honorary, for such persons as the Board of Directors may wish to honor.

From a tax standpoint, the Institute enjoys an enviable position. Being a valid non-profit corporation, it is not required to pay any tax on its receipts, and therefore 100 per cent of its income can be devoted to research and other useful projects.

Fortunately, also each member's dues and contributions are completely deductible by the member for income tax purposes.

Both tax factors therefore guarantee to the Institute's members more than full value for each dollar invested.

when the job is done and all the facts are in— you'll find STRESSTEEL overall cost is lowest!



105′ bridge girders, Olive Avenue Overcrossing, Burbank, Cal. Precast by general contractor: Ukropina, Polich & Kral, San Gabriel, Cal., for Division of Highways, Department of Public Works, State of California.

There is reason for the tremendous growth in the use of **STRESSTEEL** for prestressed concrete. Increasing numbers of users find . . .

- **STRESSTEEL** is the lowest in-place cost post-tensioning material.
- **STRESSTEEL** handles faster, providing lower labor costs for placing and tensioning.
- **STRESSTEEL** proof-tests every bar, assuring controlled quality.
- **STRESSTEEL** Wedge Anchor Units provide positive end anchorage. It is the fastest, safest and easiest post-tensioning method.
- **STRESSTEEL** tensioning equipment for rent and sale at nominal cost.

Write for new illustrated manual SS-3

STRESSTEEL CORPORATION
221 Conyngham Ave.
WILKES-BARRE, PENNA.

Fig. 1. American Delegation visits apartment construction in Moscow using pre-tensioned elements. Left to right are: Professor T. Y. Lin (head of Delegation), Professor Boris Skramtaev of Soviet Academy, Mr. Walter Price, Russian lady-architect, Professor Boris Bresler, Russian interpreter Mr. Sergeev, Mr. Ben C. Gerwick, Jr., Mr. David Billington, and Mr. James D. Piper.

prestressed concrete in russia

Prof. T. Y. Lin, University of California, who co-authored this article with Ben C. Gerwick, Jr., San Francisco, California.

1. INTRODUCTION

At the invitation of the Soviet Academy of Construction and Architecture in Moscow, an American Delegation of concrete specialists visited the U.S.S.R. in May, 1958 (Fig. 1). The purpose of the trip was to inspect recent Soviet research and development in the field of precast and prestressed concrete engineering.

The American Delegation consisted of the following members:

1. T. Y. Lin, Professor of Civil Engineering, University of California, Berkeley — as Chairman of the Delegation.
2. Boris Bresler, Professor of Civil Engineering, University of California, Berkeley — as Secretary of the Delegation.
3. David P. Billington, Engineer, Roberts and Schaefer Co., Engineers, New York City.
4. Ben C. Gerwick, Jr., President, Ben C. Gerwick, Inc., San Francisco, California, and President of Prestressed Concrete Institute.
5. Walter H. Price, Chief, Engineering Laboratories, Bureau of Reclamation, Denver, Colorado, and Past-President of American Concrete Institute.
6. James D. Piper, Vice President, Portland Cement Association, Chicago, Illinois.

A complete report is being written by the Delegation and will soon be published. It is the purpose of this paper to describe Soviet research, design, production, and construction of prestressed concrete as observed by the Delegation. Most of the material presented in this paper is taken from the manuscript for the above report.

2. GENERAL OBSERVATIONS

Our observations of prestressed concrete engineering in the U.S.S.R. were limited in time and locale: we were there only for ten days and visited only Moscow and Leningrad areas. However, because of our concentration on various phases of prestressed concrete and due to a full schedule of conferences and inspections, a surprisingly broad picture was obtained.

In prestressed concrete engineering, the development in the Soviet Union is ahead of that in the U. S. in certain respects, and behind in others. Generally speaking, they emphasize precasting, but do little in-place prestressing; they use more prestressed elements in buildings, and much less in bridges; they are well-advanced in mass production, but only beginning in unique designs; they concentrate on continuous pretensioning but have barely started on the long line process or post-tensioning as a whole.

Their emphasis on prestressed concrete was partly motivated by the desire to reduce steel consumption, although the main consideration is overall economy. Their ability to make the most of prestressing results from the state control over planning, standardization of design, and mechanization of production. The government order to build over thirty million square feet of apartments per year in Moscow alone, all of a few standard floor and wall units, makes it possible and worthwhile to highly mechanize the production techniques, thus attaining economy. Their emphasis on precasting resulted from the trend toward mechanization and also from the severe cold weather which tends to favor indoor and factory production; whereas our highway and trucking facilities together with a well-developed ready-mix concrete industry enable us to build economically either monolithic or precast structures.

The ability of the Russian engineers to design and construct unique engineering projects is not open to question. There are, however, lesser number of unique designs, when compared to Western Europe or the United States. The appearance of the structures and building products is inferior judging by our own standards. Soviet engineers often indicated that appearance was of secondary importance to them, although time will come when more attention will be paid thereto.

3. RESEARCH

There is no question that Soviet research in the field of prestressed concrete is outstanding, especially in applied research which includes the development of prestressing methods, machines, and various designs using prestressed concrete. The concentration and centralization of efforts under one or two organizations enables them to carry out costly but fruitful work not otherwise possible. This is in direct contrast with Germany, for example, where dozens of contractors are independently developing their own systems of post-tensioning.

Soviet research on prestressed concrete is essentially carried on by their Academy of Construction and Architecture. This Academy employs 8,000 engineers, scientists and technicians in 22 research institutes under its direction. The major portion of research

on prestressed concrete is carried on in the Prestressed Concrete Laboratory, under the direction of Professor V. V. Mikhailov — this Laboratory being a part of the Research Institute of Concrete and Reinforced Concrete. Related work is also carried on in the Central Institute of Structures. Some 600 persons work in the six laboratories of these two institutes; and it is estimated that about 1/3 of these are working on prestressed concrete.

These laboratories are very well equipped. (Fig. 2.) For example, there are six heavy floor slabs for testing members under bending, with slot fittings permitting a maximum load per bolt of 50 tons. One big testing slab was 230 x 33 feet. We were told that a new 400 x 66 feet testing slab is to be built soon.

Many pulsators were used for testing the fatigue strength of steel reinforcement and concrete specimens. Six pulsators were in operation and new pulsators were being installed.

Research projects in the laboratories change from time to time. The following projects were witnessed by us during our visit.

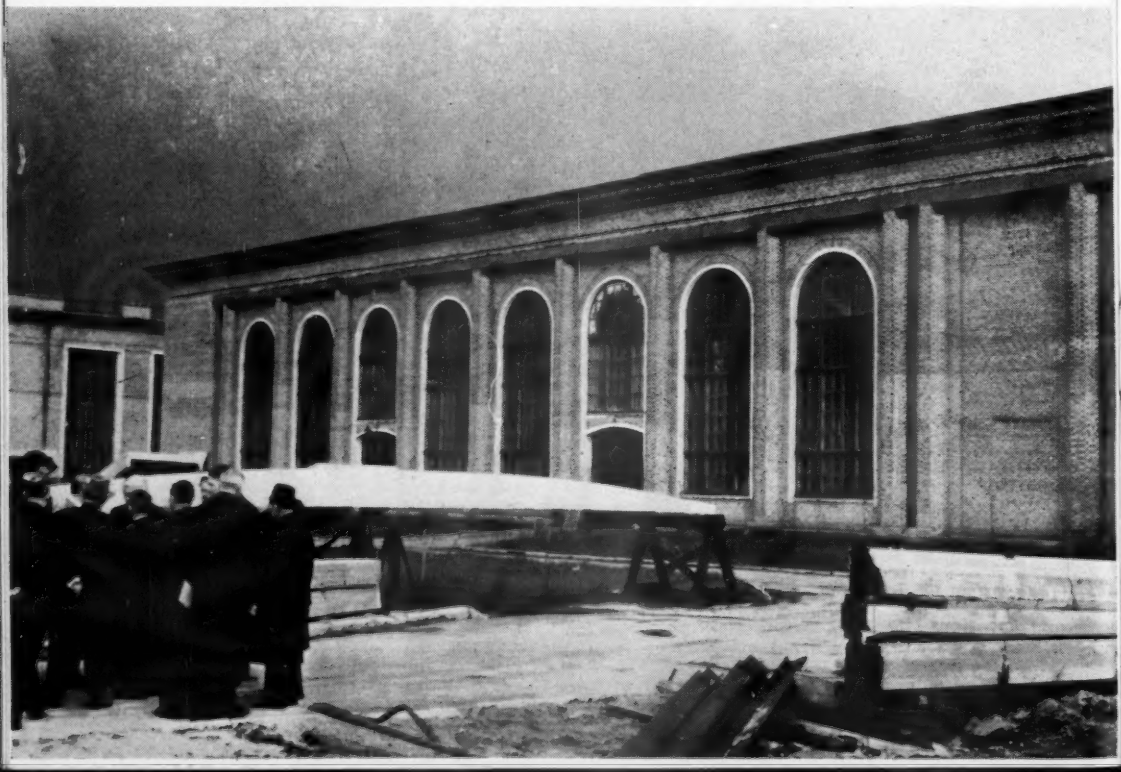
1. Monolith-Precast Prestressed Construction

Investigation was being conducted on precast pretensioned elements acting as reinforcement for poured-in-place concrete. The precast elements thus also act as forms and support during pouring. Preliminary tests showed that it was possible to utilize the ultimate tensile strength of the poured-in-place concrete, since its cracking is prevented or delayed by contact with the prestressed elements. In the tests, there was no separation between the two elements or portions, even at failure. These tests were carried out on very highly stressed beams, where the concrete strength was in the range of 10,000 to 12,000 psi. A paper on this subject was given by V. V. Mikhailov at the Third International Congress on Prestressing held in Berlin in 1958. One of the test specimens is shown in Figure 3.

2. "Self Stressing" Cement

"Self stressing" cement is a type of expansive cement, which due to its chemical composition and special hydrothermal treatment during placing and hardening expands and stresses the reinforcing bars. An investigation of the chemical composition, physical properties, and curing procedures for a self-stressing cement has been under investigation for several years. The main purpose was to control the amount and time of expansion by proper

Fig. 2. In front of Soviet Research Laboratories, prestressed thin shells are being tested.



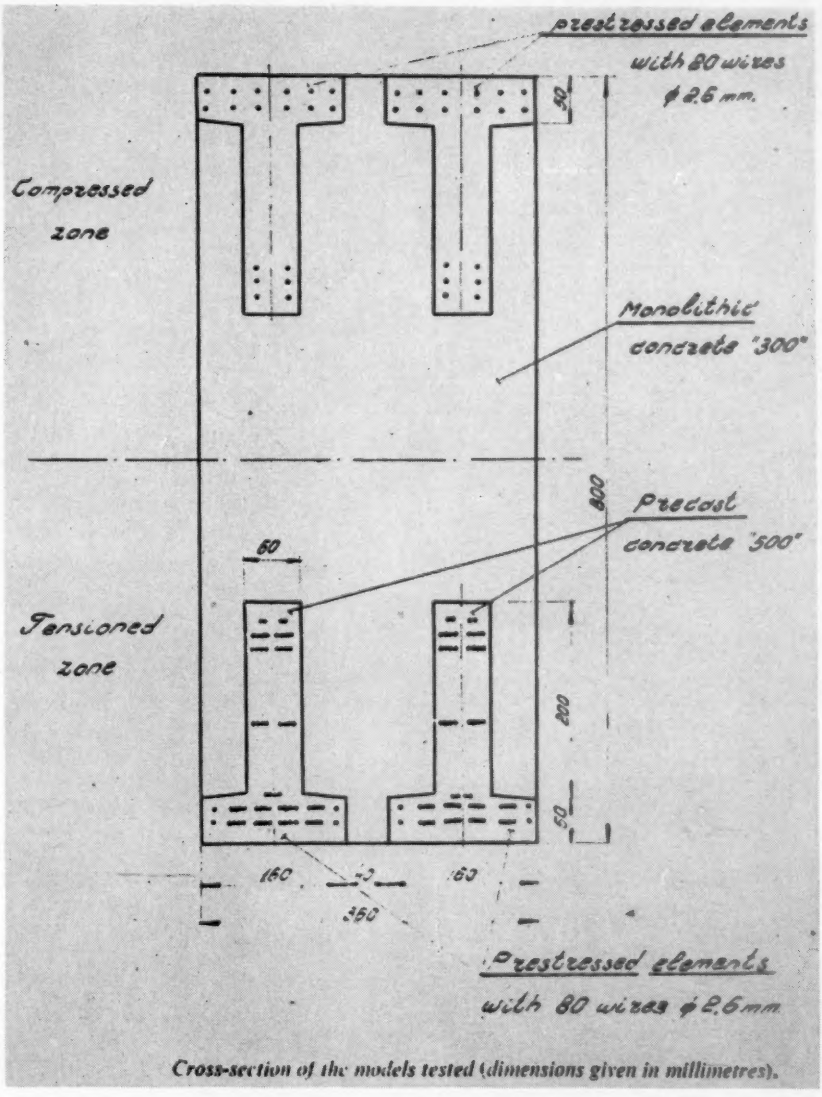


Fig. 3. Models for determining the effect of precast monolithic construction, where precast elements are used for forming and to help developing the tensile strength of in-place concrete.

proportioning and curing. Numerous small specimens were used to measure expansion and plastic flow under constant stress or constant strain. It was being put into commercial application for the self-stressing of pipes, both longitudinally and circumferentially. (Paper on this was presented by Professor V. V. Mikhailov in Proceedings, World Conference on Prestressed Concrete, San Francisco, 1957.)

3. Prestressing Machines

Essentially, two types of machines for continuous prestressing are developed and improved in the laboratory: one is the turntable with a stationary feeder head, and the other is a stationary table with a movable feeder head. This method of continuous prestressing

Fig. 4. Pre-tensioned railroad ties being tested in the research laboratory. Note the rails along the long side of the rectangular frame.

is described by Professor V. V. Mikhailov in a paper published in the Proceedings of World Conference on Prestressed Concrete, San Francisco, 1957. Plans are being made for using prestressed concrete frames instead of steel for the D.N. 7 or turntable machines.

Some other research projects are listed as follows:

4. Post-tensioning methods — anchorage device up to 400 tons per cable.

5. Large bars for post-tensioning pretensioning — pullout tests on bars up to 1 and 2 inches in diameter anchored by bond alone.

6. Corrosion in sea water — Professor V. M. Moskvin recommended 3 to 5 cm of concrete cover for prestressing steel in the tidal range and immediately above high tide.

7. Railroad tie frames — thin rectangular frames continuously pretensioned to replace wooden ties (Figure 4).

8. Precast roof shells — various types of hyperbolic-paraboloid thin shells were tested.

9. Prestressed trusses — 30 meter span roof truss built of precast units was being post-tensioned together and tested.

10. Crane girders, prestressed pipe machines, prestressed concrete autoclave units, etc., were being developed and tested.

4. DESIGN

So far as we know, there are apparently no engineers in private practice in the Soviet Union. All engineering design is concentrated in Government Design Organizations. The biggest organization of its kind is probably the Moscow Design Institute which designs and supervises all building construction in Moscow. It employs 3100 structural engineers, architects, sanitary engineers, electrical and mechanical engineers. Over half of the employees are women.

All design and construction are planned and scheduled two years ahead, and designs are now ready for 1959 and 1960. The daily work of design is greatly simplified by standardization. Catalogues are prepared by the design organizations which show available precast and prestressed structural units that are to be used in all standard construction. Standard details are published in handbooks and revised annually.

The specifications for prestressed concrete have been revised several times, and the latest issue is of 1958. These specifications are approved by the State Committee for Construction of the Council of Ministers. It is interesting to note that, instead of empirical allowable stresses the following three basic criteria are used for design: (a) ultimate strength, (b) excessive deformation, and (c) local damage — such as cracks, etc. Ultimate strength design conditions include two coefficients: one is an "overload or load factor", and another is "service condition factor" which varies for various types of structure and service conditions. The resulting factor of safety appears low in some instances, but in others appears comparable to those normally recommended in the United States.

A typical framed construction has the precast reinforced concrete columns set on precast footings. The columns would have protruding corbels on which are set precast prestressed cored rectangular beams. The cored flat floor slabs rest on these beams. The connections for the precast units are made by welding and grouting. We were informed that studies were being made to use prestressed concrete even for the footings and columns. Indeed, some crane columns were already prestressed.

Special individual building designs are made only occasionally in this organization. The Chief Engineer showed us plans for the Permanent Building Exposition in Moscow with a span of 200 ft. The roof is to be made of corrugated precast thin shells, with a structural depth of 8 ft. The sections are to be precast in length of about 15 ft. and are to be prestressed together after assembly on the job-site.

As another example, the Design Institute No. 1 located in Leningrad differs from the Moscow Design Organization in that it specializes in large civil engineering and industrial projects such as shipyard construction, hydroelectric plants, docks, hangars, repair shops, industrial plants and buildings. Only about 10 percent of the work is done for Leningrad, the rest is scattered all over Russia, and even in China, Czechoslovakia, Poland, Hungary, etc. This Institute at present employs 650 people.

Many of the projects of this Institute, owing to their very nature, have to be individually designed. However, whenever possible they standardize the projects. For example, they are working on standardization of precast shells for factory and other buildings. It was also reported that they were working on standard designs for prestressed concrete transmission towers.

One daring unusual design was shown to us — a stadium cover of 500 ft. x 820 ft. supported only on columns along the perimeter with no intermediate supports. This will be made up of precast units, joined and post-tensioned both along the edges and across the corners. It will have an average thickness of concrete of no more than 6.3 inches.

Both for drydock construction and for dams, they were introducing the use of precast prestressed panels for forms and for composite action. A typical panel size would be 66 ft. long x 13 ft. wide and 4 in. thick. It was felt that the use of such forms simplifies the construction, speeds up concreting, economizes the job, and increases the longevity of the structure. Great quantities of precast forms were used in the construction of the Kuybyshev Hydroelectric Station on the Volga River which has a capacity of 2,100,000 kw.

Figure 5 shows a precast post-tensioned truss for industrial buildings. The roof truss is made of five precast pieces and post-tensioned with three cables strung through preformed holes; two running the full length of the bottom chord, and the third raised up through the last tension diagonals.

It will be interesting to describe two types of precast prestressed concrete thin shells being developed and built in Leningrad. The first shell is 131 ft. square, supported on four corners only and made up of 135 precast elements, of 16 different types, each weighing about 3½ tons. The entire shell, weighing 560 tons, was assembled on falsework at ground level by welding, grouting, and prestressing. Then it was lifted 66 ft. to slightly above final position,

by use of a temporary column at each corner of the square. Then the permanent columns, made up of precast circular hollow core units, each about two ft. sq. by three ft. high were erected in place with a crane and the shell lowered onto them.

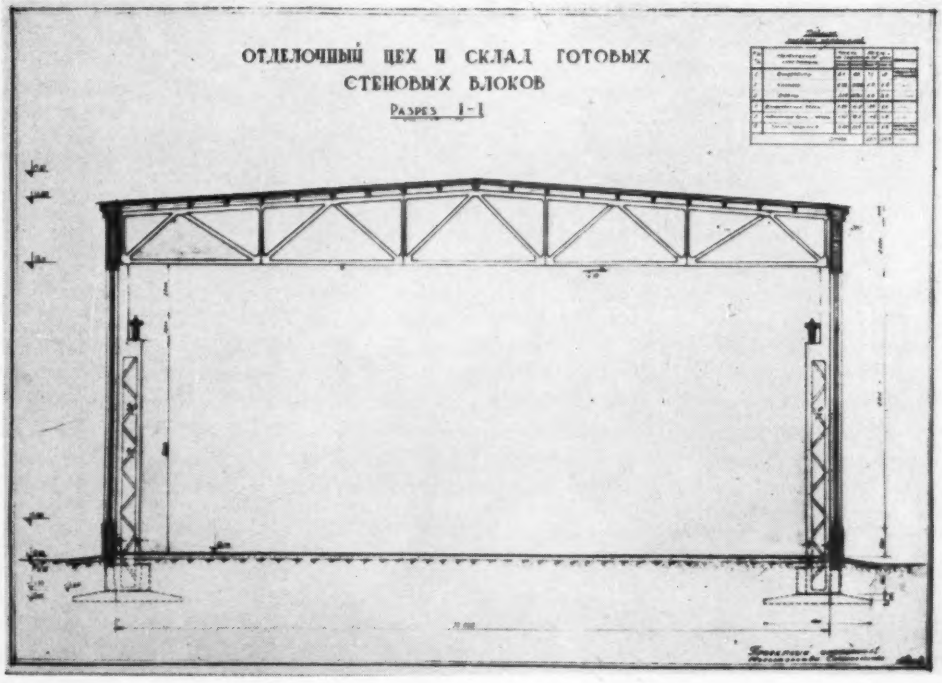
The shell itself was 4 in. thick with ribs 10 in. deep, (Figure 6). Each of the four edges of the shell was supported in a vertical plane by a shallow truss made of precast elements. Post-tensioning was applied to the trusses and to the four corners of the shell. To simplify erection, the trusses were assembled flat on the ground and then tilted up and connected to the shell on the ground-height falsework.

After tensioning the cables, initially, they waited two months to check the loss of prestress before performing the final tensioning and the grouting. No special means were taken to prevent corrosion during the two months. After the first shell was completed, but before raising, it was tested under superimposed loads. In lifting the shell, there was one jack with two rams operating at each corner. The first shell took 11 hours to lift — it was during a heavy storm. The second shell took only about half that time.

The lower chord of the trusses for the first shell was of rectangular section, with 15 tubular voids for the prestressing cables. There was difficulty in inserting the cables through the voids and in grouting them. For the second shell, a U-shaped section was adopted for the bottom chord. Cables were laid in the trough and post-tensioned; then the trough was filled with concrete. This represented a big improvement. The diagonal post-tensioning cables in the corners of the shell proper were inserted through ducts in both shells.

A second type of precast prestressed concrete shell has a 328 ft. span, see Figure 7. The entire building consists of eight arched barrel shells, each 25 ft. wide and separated from the next by a 8 ft. width of skylight. Thus an area of about 256 ft. x 328 ft. is covered without a single interior column. Each arched shell is fabricated at ground level, and lifted into final position.

Fig. 5. 100-ft. precast post-tensioned truss resting on pretensioned crane columns for a factory building.



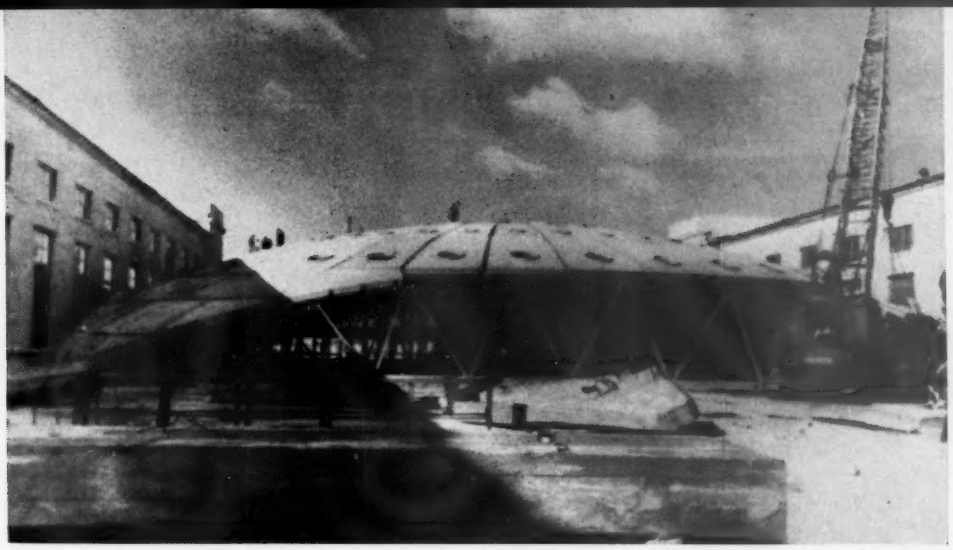


Fig. 6. Precast and post-tensioned thin shell being assembled and post-tensioned on the ground, to be lifted into position. Shell is 131 ft. square in plan and supported on four corner columns.

The arch has a rise of 35 ft. at the center and will be tied by means of a prestressed concrete lower chord which will also support 10-ton cranes. Each arch is made up of 13 precast elements about 30 ft. long and weighs 406 tons in total. It will have an average thickness of 6.3 in. with a minimum thickness of 2.4 in. The tie is a thin vertical web, with grooves on both sides, in which the prestressing cables will be placed and then concreted.

The shell units are precast in a casting yard, delivered and placed by a large gantry revolving crane, and joined by welding and grouting. The forms for these units are made of ferro-cement concrete panels, 3 cm thick, reinforced with mesh. These forms are quite flexible and are supported by light steel framing.

5. PRODUCTION

The production of precast and prestressed concrete elements in the Soviet factories possess certain important features which deserve attention. These are enumerated as follows:

1. Standardization of units
2. Specialization by each plant on a limited number of items
3. Mechanization for production of the standardized units
4. Large size of individual plants, permitting mechanization and resulting in economy
5. Long range scheduling of production, involving no problem of sales
6. Coordination of research, design, manufacture and construction

By combining these advantages, the Soviet precast and prestressed concrete industry has developed in certain areas — particularly in the production of floor slabs and walls for apartment buildings — so that its capacity, output, and perhaps economy are unequalled in other countries. On the other hand, from the point of view of efficiency and of quality, there still is much left to be desired. It is pointed out, for example, that with all the mechanization and standardization, the man-hour of labor per unit of concrete is just about the same as that in the United States plants where a variety of products are produced in relatively small quantities and mechanization is not nearly as complete. This is probably because not sufficient advantage has yet been taken of the new process of mechanization. It was partly explained by the lack of experienced workmanship.

The pretensioning process developed in the Soviet Union differs radically from that in Western countries. Whereas we prestress on a long-line process, the Russians employ the continuous process almost exclusively. In this continuous process, the wires are stretched

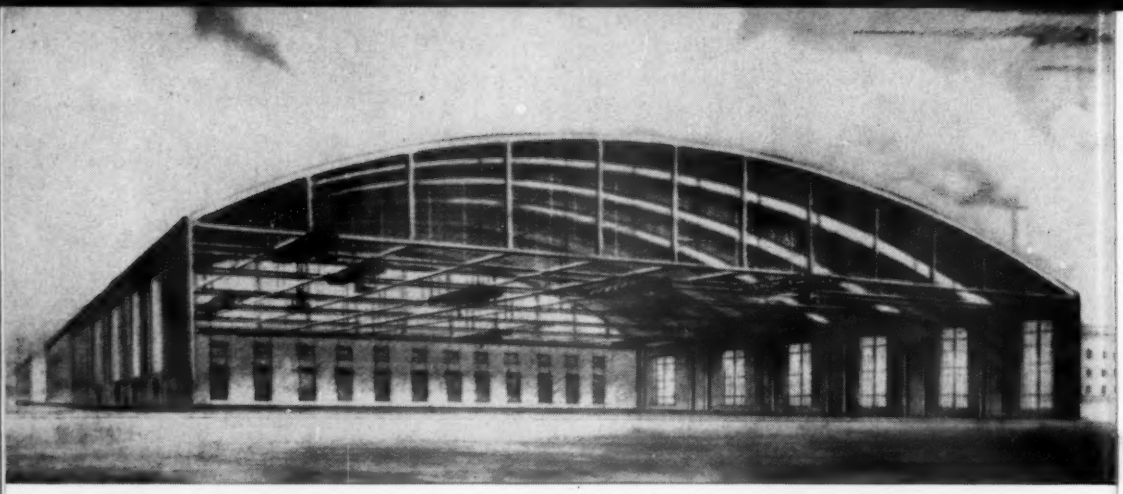


Fig. 7. Factory of 328-ft. clear span roofed by precast post-tensioned concrete thin shell, assembled on ground and lifted into position.

out, tensioned and bent around pegs held to the pretensioning frame. The process is somewhat similar to the Preload wire-winding procedure developed in the States, although much more advanced. It has the advantage that the wires can be laid out in any desired pattern.

The first experimental stressing machine in the Soviet Union was completed in 1945, and the production of these began in 1949. In 1957 about 35 machines were in operation. It is their plan that this number will increase to 120 by 1960.

There are two distinct types of stressing machines in the Soviet Union. The universal turntable was first developed. This winds and stresses the wires horizontally on itself as it turns. A later invention was the spinning machine, which spins and stresses the wires on a stationary table (Figure 8). There are several variations of this latter type, made by various government factories, apparently on a competitive basis.

The essential difference between our production of prestressed concrete and theirs could be summarized as follows: "They move their products to the process as in an automobile assembly shop, whereas we move the process to the product by our long line process."

After prestressing their wires on it, Figure 9, the frame is moved to the casting area where the concrete is poured and vibrated. Then the frame with the concrete is moved to the steam pit for curing. After about eight hours of curing up to 95 degrees Centigrade, the unit is stripped from the frame and moved to the storage yard.

A typical product is the cored floor slab, Figure 10. These slabs are 9 in. deep x 4 ft. wide x 16 to 22 ft. long. Some slabs have 6 holes of 6½ in. diameter. One production line would produce one slab every 15 minutes. Thus for a factory with four production lines, working in three eight-hour shifts, it is possible to produce 800,000 sq. meters of slabs per year.

The total production of prestressed concrete in the Soviet Union was given as 1,200,000 cu. meters in 1957; the amount of precast concrete products, with and without prestressing, was about 9,000,000 cu. meters, and the total amount of concrete work both precast and in-place, was about 25,000,000 cu. meters. It was their plan that by 1960, annual production of prestressed concrete products will amount to 7,000,000 cu. meters; precast products to 25,000,000 cu. meters, and total concrete work to 80,000,000 cu. meters. These figures indicated their emphasis on concrete in general, and precast and prestressed concrete in particular.

In the city of Moscow alone, there are a total of 25 precast factories in 1958, aggregating 2,000,000 cu. meters of products per year. We visited two of the largest ones. Factory No. 6, the biggest in Moscow, is scheduled to produce 170,000 cu. meters of concrete in 1958; and it is planned by 1965 that the capacity of this plant will go up to 300,000 cu. meters per

Fig. 8. Soviet stressing machine D.N.7. The swivel arm traverses in any regulated pattern. It tensions and loops the wires around the pegs set on the steel frame. This enables pretensioning in two directions.

year, essentially by improvement in production methods and efficiency, but without additional factory area. (Note that the above volumes included the voids in the cored-slabs, and the amount of solid concrete production is about 30% less than as given.)

As an example of Soviet conversion from precast into prestressed production, Factory No. 6 in Moscow had 44% of its products prestressed at the time of our visit. We were informed that by the end of 1958, prestressing will be applied to 100% of their products.

Fig. 9. Steel frame complete with pre-tensioned wire, reinforcing cage and steel side forms; note the steel cores at lower left corner are ready to be pushed into position to form the voids.

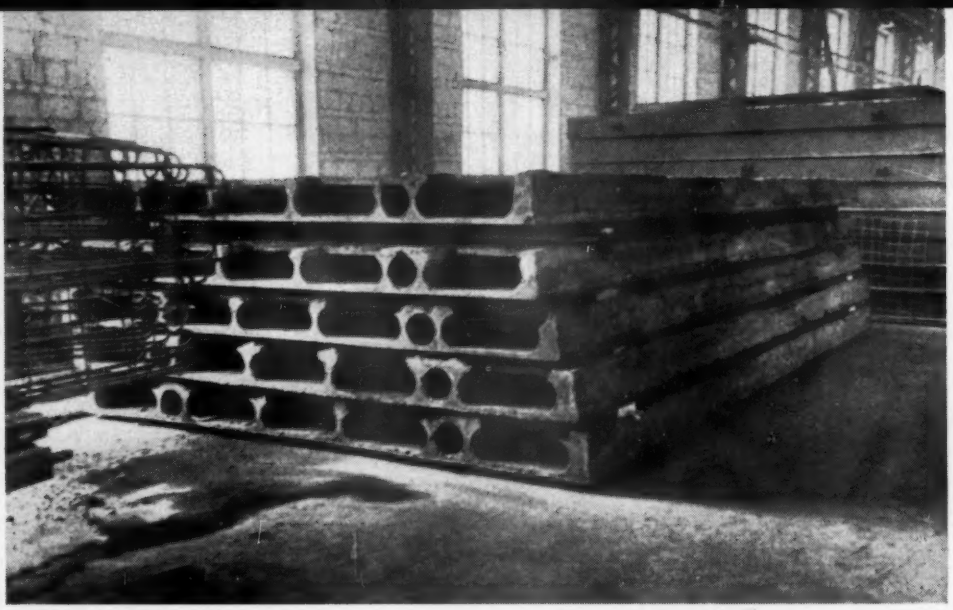


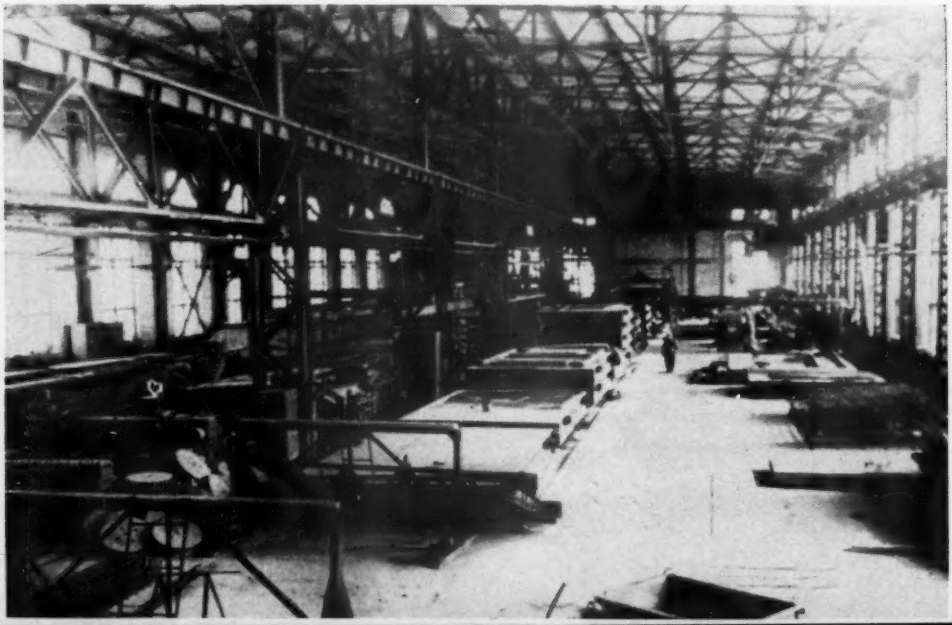
Fig. 10. Some typical prestressed cored slabs for apartment buildings.

Economy was given as the main reason for this conversion, since prestressing results in saving of material, labor, and overall cost. But it was also pointed out that lighter and better quality products were obtained as a result of prestressing. Furthermore, a saving of 30,000 tons of steel is effected per million cu. meters of products prestressed.

The amount of mechanization and the cost of the factory are justified by the big volume of production. For example, it is estimated that the initial cost of a typical Soviet factory producing 170,000 cu. meters per year would be about $5,000,000 in the United States, exclusive of land. Since the value of the products per year, translated to U. S. prices, would be approximately $12,000,000, it is evident that the high capital investment can be easily justified, if this amount of sale can be guaranteed.

Soviet production of prestressed concrete units for bridges is apparently far behind our attainments. This is partly explained by the fact that the total amount of bridges being

Fig. 11. The interior of a precasting prestressing factory.



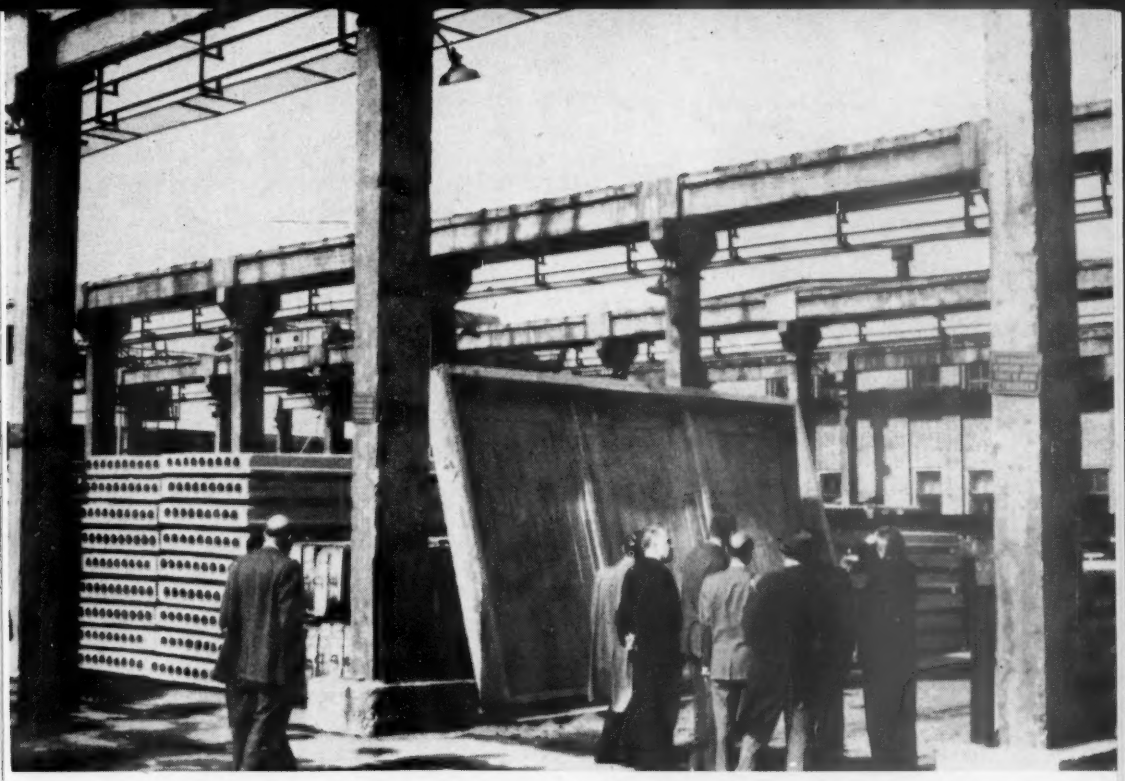
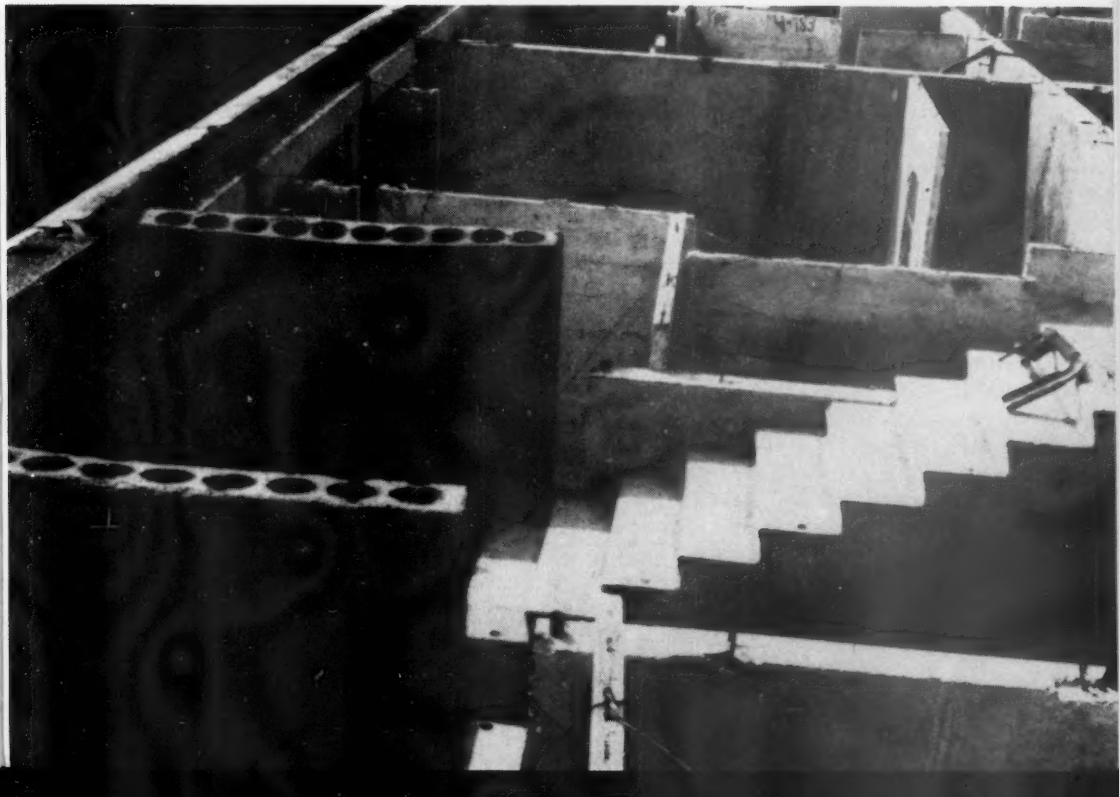


Fig. 12. Storage of cored prestressed slab at left; at center, a square slab panel pretensioned in two directions.

•

Fig. 13. The assembling of precast and prestressed elements for an apartment building.



built in the Soviet Union is nothing compared to what we are building under our highway construction program. Their emphasis is almost solely on apartment construction, which is their major use of precast prestressed elements at the present time.

To give an idea of the magnitude of their biggest plants, three precasting and prestressing factories visited by us are summarized and described in the following table:

	Factory Number		
	No. 6	No. 4	No. 5
1. Location	Moscow	Moscow	Leningrad
2. Principal type of product	Cored slabs	Cored slabs and channel slabs	Cored slabs
3. Other products	girders railway slabs large panels		
4. Present annual production capacity* m^3	170,000	125,000	80,000*
5. Projected annual production capacity* m^3	300,000 (1965)	—	192,000* (1959)
6. Present Prestress production %	44	40	70
7. Projected % of prestress projection	100 (1959)	100 (1959)	70 (1960)
8. Workers employed	500	400	500
9. Productivity $\frac{m^3}{m\text{-}hr}$	0.167	0.125	0.18 (projected for 1960)
10. Cost of plant	—	50,000,000 rubles	(we estimated at approx. $5,000,000 U.S. equivalent)
11. Cost of annual product	—	32,500,000 rubles	—

Plant is just being finished; operating at less than half projected capacity which is 192,000 cu. m in this plant. The figures quoted were solid volume which should be adjusted for void ratio of product.

6. CONSTRUCTION

Because of the program for decentralization of industry and for alleviation of urban congestion, there is very little industrial construction in Moscow and Leningrad areas. Such industrial construction as we saw was largely related to the housing program, particularly factories for precast prestressed concrete.

The 1958 construction program includes apartment buildings providing 2,300,000 sq. m (25,000,000 sq. ft.) of "living area" in Moscow and about 800,000 sq. m. in Leningrad. This is equivalent to 64,000 apartments in Moscow and 22,000 in Leningrad. The "living area" is calculated exclusive of kitchen, bathroom, hall, stairs and walls, so that to convert to U. S. equivalent building area about 30% must be added to "living area".

Also there are 40 schools to be built in Moscow each year, in addition to hospitals, office buildings, and dwellings. The entire Moscow program requires 2,000,000 cubic meters of precast and prestressed concrete per year. Since this value includes about 25 percent voids in the hollow concrete cores, it is equivalent to about 1,800,000 cubic yards of solid concrete. At the present, less than half of the precast concrete units are prestressed, but it is believed that more and more prestressed work will take the place of the conventional reinforced concrete. It is estimated that each square meter of living area requires about ½ cubic meter of precast concrete (including voids).

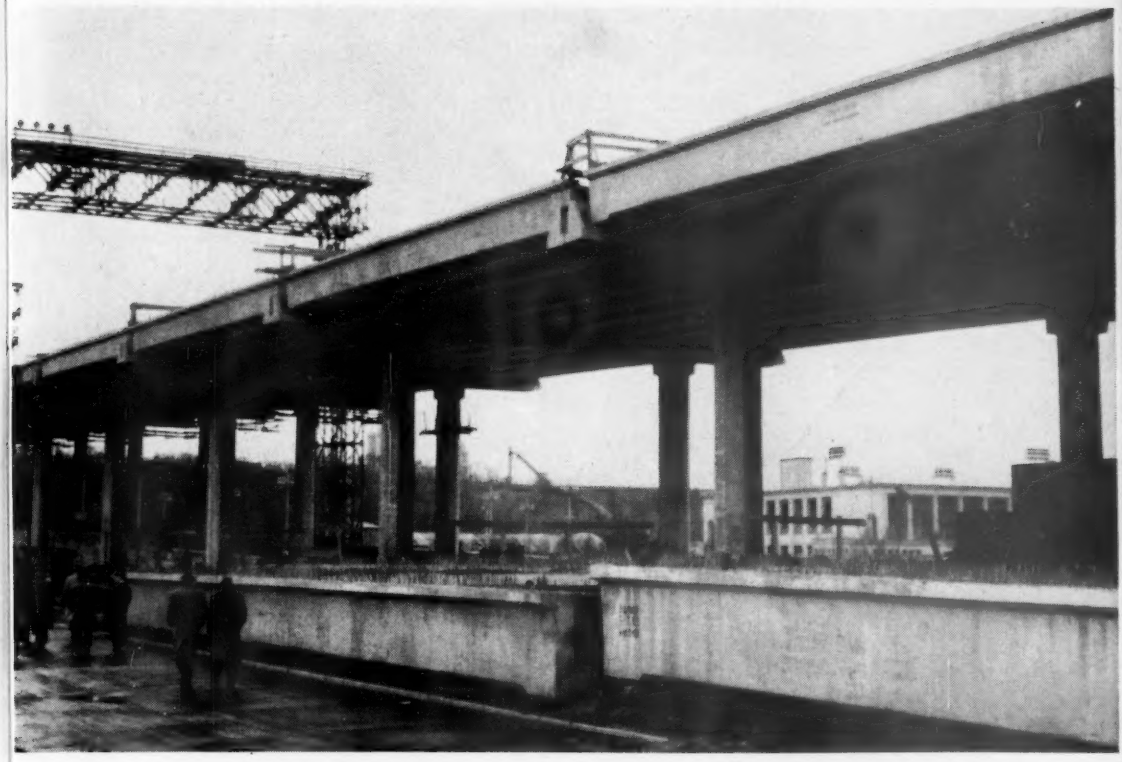


Fig. 14. Approach to the Moscow River Bridge, using precast post-tensioned girders of 72-ft. spans.

In Leningrad we visited a group of 8 apartment buildings, of 5-stories high, each building containing 60 to 80 apartments, thus providing a total of some 600 apartments in the group, with a total living space area of 20,000 sq. m. These buildings form a court, in the center of which is provided a large park area, including a kindergarten and a nursery building.

All the apartment buildings we saw were built using precast reinforced or prestressed concrete from the foundation footings to the roof, including walls, partitions and stairways. Ventilation ducts are provided by the hollow cores of slabs placed as a vertical partition. Radiators and heating wall panels are slabs with embedded steel pipes. Electrical ducts are formed with glass tubes of 1 to 1½ in. in diameter embedded in concrete, with no apparent chemical reaction between the glass and the concrete. Non-bearing partitions were made of slag concrete or gypsum, and gypsum suspended ceilings were used.

Attempts were being made to schedule erection so that the precast panels can be delivered from the factory to the site by truck, and lifted directly to the final position, thus avoiding the cost of stockpiling and rehandling the panels at the site. Tall tower cranes were usually utilized for erection, and in Leningrad we saw one tall gantry crane used for erection of an eight story apartment building.

In Leningrad a group of apartment buildings was constructed in four stages, so that one crew puts in utilities and foundations, a second erects panels and units, a third completes the structure, and a fourth does the finish work. Each crew moves on from building to building as they complete their phase. The above project took 19 months to build, with each building taking some 125 days from start to finish.

We visited the construction site of the Moscow River Bridge, a new combination automobile and subway (Metro) bridge across the Moscow River connecting the sports area of the city proper on one side of the river and Moscow University area on the other side with the main subway system. This structure will permit extension of the Metro to provide direct service to the University and the adjacent large residential area now being developed. This was the only bridge that we saw under construction in Moscow, but it was a spectacular structure, uniquely conceived, demanding first class engineering skill for its design and execution.

It is a two-level prestressed concrete bridge, with the upper deck carrying eight lanes of highway traffic, and the lower deck carrying two tracks (one in each direction) plus a Metro station directly over the Moscow River.

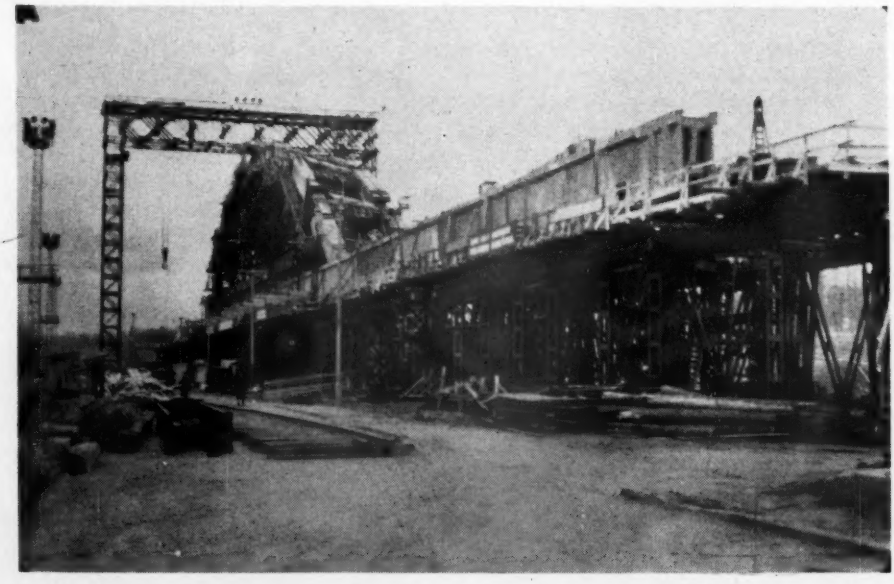
The length of the bridge proper is 4,000 ft. including the approaches. The main span is built on a 37 degree skew and consists of an arch 354 ft. long flanked by two smaller arches at 148 ft. span, thus making the main crossing 650 ft. The other spans are essentially 72 ft.

The arch spans have four ribs each and are being built along the shore in two halves — each half made up of two main carrying elements 650 ft., supported only at the intermediate piers, with a 148 ft. cantilever overhang at each end. During the floating operations temporary steel cables will tie the cantilever ends over the center span, thus making it possible to transport the assembly on two supports. The weight of each assembly is 5000 metric tons. This includes the structure of the lower deck, while the upper highway deck will be erected only after the assembly has been placed in final position.

The assembly on the bank would be moved sidewise on rollers out onto two timber piers. Four pontoon barges (two under each support) would float under the unit, pick it up and move it to position. The pontoons would be gradually lowered by flooding so that the unit would sit on its piers. At the time of our inspection, the first assembly was nearing completion on the bank — almost ready for the floating operations.

It was stated that this particular design was selected after a study of and analysis of 12 alternate designs, including designs in steel. We were later informed that this type of design was now being used to construct two other major bridges in Siberia. There is apparently an attempt to standardize or repeat novel designs once they are proved to be economical. The arch ribs, suspenders, and lower chords are all made up of precast elements joined by welding and grouting, with joints about one foot wide. The lower chords are post-tensioned.

Fig. 15. Main span of Moscow River Bridge with 354-ft. center opening and two flanking spans of 148-ft. Each assembly of 650 ft. and weighing 5000 tons is being erected on shore, to be floated into position.



The approach spans are also of precast prestressed concrete. The 72-ft. girders are of U-shape with end blocks and three diaphragms and weighed 37 tons apiece. They were approximately 4 ft. deep and 5 ft. wide. After they had been cast, they were post-tensioned with external cables in the factory and the cables were then encased in concrete. The bridge construction group has its own precasting factory, and these units were of much better quality than the building panels we saw in the previous precast factories. They appeared structurally strong, true to line and dimension, and free of honeycomb, although the surface finish was still poor.

The precast cap units were roughly "L" shaped in cross-section. Two of these with their legs facing each other formed the cap. Pouring the trough in-between full of concrete also provided the connection to the column. The columns were of precast reinforced concrete. When they got too long to be handled in one section, they were spliced, by welding embedded plates doweled with reinforcing bars into the column sections. All precast units were delivered to the bridge site by rail and truck, the larger units, of course, moving by truck.

For the erection of the precast units in the approach and in the arch ribs, giant gantry cranes were used. These have a capacity of 50 tons, and a span of perhaps 150 feet. They were of standardized steel elements, giant "erector sets," which could be assembled as required to build different towers and gantries. They belong to the bridge construction group and are used for many jobs. They spanned not only the bridge itself but about 60 ft. of delivery and storage area alongside. In the States, probably large crawler cranes would be more efficiently used.

On these girders, precast deck slabs were placed transversely and joined with deck pours that make the slabs act compositely with the girders. Sidewalk brackets are also precast prestressed, and stick out through slots in the sides of the girders. Precast sidewalk slabs were to be placed on these brackets.

7. CONCLUSION

The fast growth of prestressed concrete throughout the world is very much evidenced by the progress in the Soviet Union. Generally speaking, mass production techniques are being developed and applied most in Russia and the United States, while basic research and unique designs are pioneered in Western Europe. There is a great deal which one can learn from another. While it is not possible for any country to directly copy other's methods, many foreign ideas and approaches can help lead to fresh avenues of attack.

There is a common bond among engineers of all countries, perhaps even beyond the techniques of prestressing. Since engineers are all concerned with seeking and applying the laws of nature for the benefit of mankind, it is evident that exchange of technical information will lead to better understanding among peoples. It was with this in mind that the trip was made and this report was written.

Acknowledgment is due to President N. V. Bechtin and Professor Boris Skramtaev, of the Soviet Academy of Construction and Architecture, to Mr. V. A. Kutsherenko, Chairman of the Soviet State Committee on Construction, and to all others who hosted the American delegation during the visit. The support given the trip by our National Science Foundation in Washington, D.C., is also appreciated.

PRESTRESSED CONCRETE INSTITUTE

425 N. E. FIFTH STREET

BOCA RATON, FLORIDA

MEMBERSHIP QUALIFICATIONS

SCHEDULE OF DUES

Anyone engaged in the production of prestressed concrete, or in the production of materials or equipment allied to the prestressing industry; licensed architects and engineers; engineers and architects in training, and students enrolled in accredited schools of architecture and engineering, are invited to apply for membership in the Prestressed Concrete Institute. Membership classifications have been established as follows:

ACTIVE

Organizations and individuals actively engaged in the production of prestressed concrete products.

Annual Membership Dues **$250.00**

ASSOCIATE

Organizations and individuals engaged in the production of materials and equipment allied to the prestressed concrete industry.

Annual Membership Dues **$250.00**

PROFESSIONAL

Limited to registered architects and engineers.

Annual Membership Dues **$ 25.00**

AFFILIATE

Limited to supervisory and technical employees, non-graduate.

Annual Membership Dues **$ 15.00**

JUNIOR

Limited to architects and engineers in training.

Annual Membership Dues **$ 15.00**

STUDENT

Limited to students of accredited architectural and engineering schools. **$ 10.00**

(For student members outside continental U. S., Canada included) **$ 12.00**

Members receive the PCI JOURNAL, a quarterly technical publication, and PCItems, a monthly news bulletin, without additional cost, plus research bulletins and other information on prestressing as it becomes available.

APPLICATION FOR MEMBERSHIP IN THE PRESTRESSED CONCRETE INSTITUTE
(A non-profit corporation)

I am applying for membership in the classification checked:

☐ ACTIVE (producer). Membership dues: $250.00 annually.
Engaged in the following types of prestressing:

_____Post-tensioning _____On-the-job post-tensioning
_____Pre-tensioning _____On-the-job pretensioning
_____Combination of both _____Precasting _____Design

☐ ASSOCIATE (related business). Membership dues: $250.00 annually.
I am in the business of:_____

_____

☐ PROFESSIONAL (registered architect or engineer). Membership dues: $25.00 annually.
I hold Certificate No._____of the State of_____

☐ AFFILIATE (technical and supervisory personnel). Membership dues: $15.00 annually.

☐ JUNIOR (limited to architects and engineers in training). Membership dues $15.00 annually.

☐ STUDENT (limited to students of accredited schools of architecture or engineering).
Name of School_____
Membership dues: $10.00 annually. Outside continental U.S.A. including Canada: $12.00 annually.

NAME OF COMPANY APPLYING FOR ACTIVE ASSOCIATE MEMBERSHIP_____

_____

ADDRESS_____

CITY_____ STATE_____

NAME OF REPRESENTATIVE IN INSTITUTE AFFAIRS_____

APPLICANTS FOR PROFESSIONAL, AFFILIATE, JUNIOR AND STUDENT MEMBERS PLEASE FILL IN BELOW:

NAME_____

ADDRESS_____

CITY_____ STATE_____

COMPANY AFFILIATION_____

POSITION_____

Date_____ Signature_____

Make no payment until application is approved. Dues will be prorated from April 1 for all classifications.

Only

$37.50

FOR THIS SPACE TO PRESENT YOUR PRODUCT OR SERVICE TO THE INFLUENTIAL PEOPLE IN THE PRESTRESSING INDUSTRY

CONCRETE TESTERS

The World's Finest Low-Cost Precision Testers

For

CYLINDERS

CUBES

BLOCKS

BEAMS

PIPE

IF IT'S A CONCRETE TESTER YOU NEED-GET IN TOUCH WITH

FORNEY'S, Inc.

TESTER DIVISION

P. O. BOX 310 · NEW CASTLE, PA.

PROFESSIONAL service advertising

This PROFESSIONAL SERVICES *section has been established to enable engineers and architects to list the services they offer to the prestressing industry. Advertising rates are $10.00 per column inch. Copy should conform with ethical standards for advertising as established by the various professional associations which govern advertising of architects and engineers. Copy and inquiries should be directed to the* JOURNAL *Publication Office: 3132 N. E. 9th Street, Fort Lauderdale, Florida.*

LEAP ASSOCIATES

Consultants to the Prestressing Industry

Lakeland, Florida

P. O. Box 1053 **Ph MU 8-5631**

WAYLAN ENGINEERING CO.

Structural Consultants

A. M. OZELL E. ARDAMAN

PAUL M. ZIA, Consultant

Consultants in Prestressed Concrete
Reinforced Concrete — Steel Design

1520 N. W. 13th Street

Gainesville, Florida

FREDERIC A. NASSAUX ASSOCIATES

Consulting Engineers

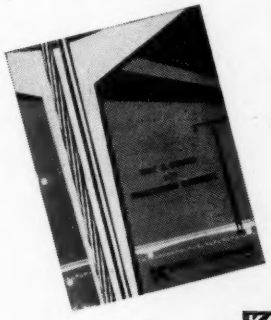
Room 226 **Trust Building**

CHAMBERSBURG, PA.

SAVE 25% or more
on prestress wire and strand

Everything about this quality imported wire and strand is equal to the domestic product — **except the price!**

That's why more and more prestressors are changing over to the KOC line. to the KOC line.



Send for this booklet

KOC PRODUCTS FOR PRESTRESSORS
(All to ASTM Specifications)
Wire to ASTM A-421-58T
Strand to ASTM A-416-57T
Test certificates supplied.

For lateral reinforcement, stirrups, spirals, etc.:
Wire rods to ASTM A-15-54T
Bright wire to ASTM A-82

Reinforcing bars to ASTM A-15-54T and ASTM 305

All at substantial savings.

KURT ORBAN COMPANY, INC.

34 Exchange Place, Jersey City 2, New Jersey
Member of Prestressed Concrete Institute

CURRENT PCI PUBLICATIONS

Specifications for pre-tensioned prestressed concrete (Tentative) — SPC-100-57T
4 pages 35c per copy

Standard prestressed concrete beams for Highway Bridge Spans — STD-101-57
30 ft. to 100 ft. Prepared by Joint Committee AASHO and PCI.
1 sheet 30c per copy

Specifications for post-tensioned prestressed concrete (Tentative) — SPC-102-58T
4 pages 35c per copy

PCI Standards for Prestressed Concrete Plants (Tentative) — SPC-103-58T
12 pages in covers: $1.00 per copy (50c to PCI members)

Underwriters' Laboratories, Inc. Report R-4123-1, May 12, 1958 — R-104-58
Precast Floor or Roof Double Tee Slab. 24 pages in covers.
$2.00 per copy ($1.00 to PCI members)

Typical Prestressed Concrete Products — STD-105-58
20 pages in covers: 10c per copy

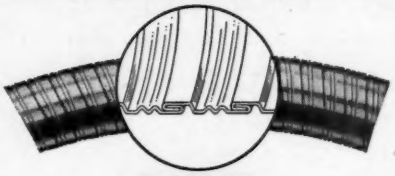
JOURNAL OF THE PRESTRESSED CONCRETE INSTITUTE
Published quarterly. Subscription: $6.00 per year domestic ($7.20 outside continental limits of USA). Back copies $2.00 each.

PCItems—Published monthly. Subscription $2.50 per year. Special quantity rates available to PCI members.

Subscriptions or orders for all PCI Publications should be addressed to:
PUBLICATION OFFICE
PRESTRESSED CONCRETE INSTITUTE
3132 N. E. Ninth Street
Fort Lauderdale, Florida

Check or money order should accompany order and be made payable to:
PRESTRESSED CONCRETE INSTITUTE

Lower Cost
Flexible
POST TENSION CASING



U-100WP
(Wide Profile)
ECONOFLEX
Ask for Bulletin U-100WP

QUALITY... *All Metal*
Flexible Hose Products
Universal
METAL HOSE CO.

2187 S. Kedzie Ave., Chicago 23, Ill.

P. C Items

Published monthly by

Prestressed Concrete Institute

This lively illustrated news bulletin presents news of Institute activities . . . views of members facilities . . . highlights outstanding prestressed concrete applications, and reports on latest developments in research, production of prestressed concrete.

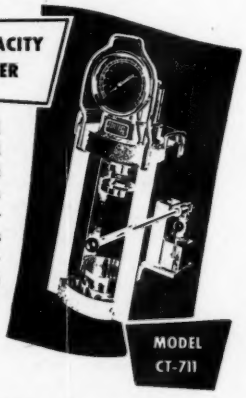
Subscription $2.50 per year

PCItems
3132 N. E. Ninth Street
Fort Lauderdale, Florida

accurate testing...

ASSURES CONSTRUCTION PERMANENCE...SAVES MATERIALS, TIME AND MONEY...

A steel constructed and integrally welded Concrete Tester that is calibrated for accuracy using U. S. Bureau of Standards certified calibration apparatus. The CT-900 meets ASTM and AASHO specifications for hydraulic testing machines and is accurate to within 1% of the indicated load.



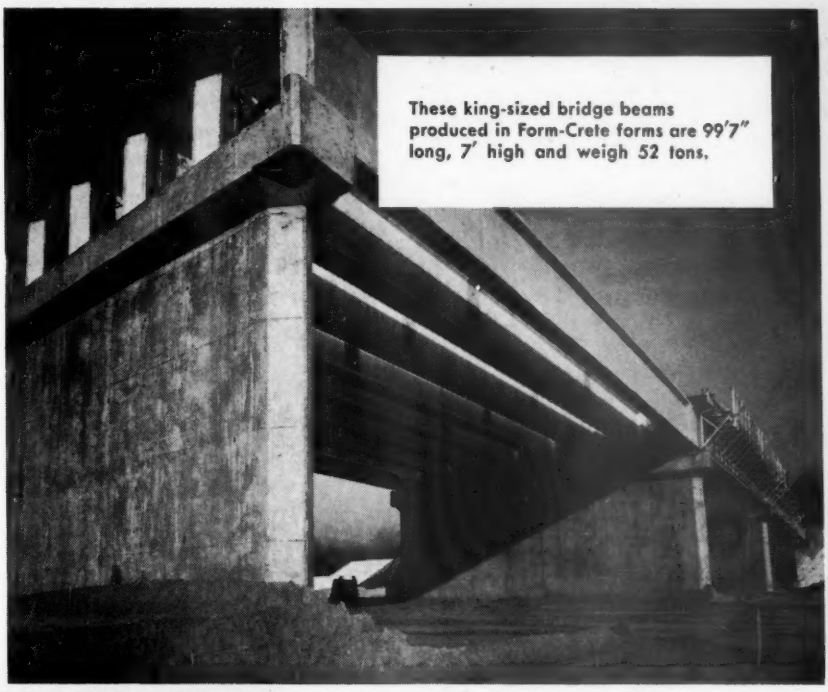
A sturdy, compact and entirely self-contained unit. Easily operated either by hand or by an electrical pump attachment. The CT-711 is also calibrated for accuracy to within 1% of the indicated load.

Many other units of Engineering Test Apparatus for Concrete Testing are available. Our New Catalog covers completely all testing equipment and accessories used in this field. Illustrated Bulletins describe in detail the Apparatus shown above.

SOILTEST Incorporated

WRITE TODAY FOR COMPLETE INFORMATION

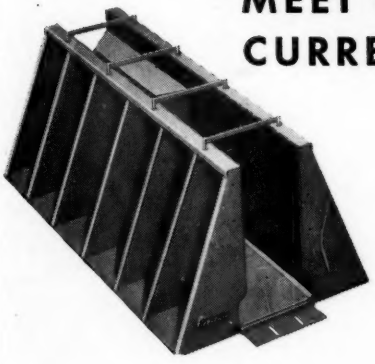
4711 W. NORTH AVE., CHICAGO 39, ILLINOIS



These king-sized bridge beams produced in Form-Crete forms are 99'7" long, 7' high and weigh 52 tons.

FMC FORM-CRETE BRIDGE BEAMS

MEET REQUIREMENTS OF ANY CURRENT PRESTRESSING TECHNIQUE



Form-Crete P.C.I.-A.A.S.H.O. approved bridge beams assure national standardization, permit quick setup and stripping time.

What prestressing techniques do you favor? Pretensioning with straight or deflected strands, post-tensioning, or a combination of pretensioning or post-tensioning?

With Form-Crete Bridge Beam forms you can use any acceptable type of prestressing in current practice. In addition, the heavy plate construction of Form-Crete Bridge Beam forms enables the producer to handle the entire individual beam length at one time when pulling or resetting the forms.

What's more, form lengths are fabricated in 10-foot standard intermediate and end sections and combinations of 20″ and 40″ sections to provide the exact beam length desired. Don't delay. Write today for detailed information.

Putting Ideas to Work

Form-Crete Department

FOOD MACHINERY AND CHEMICAL CORPORATION ®

General Sales Offices:
Lakeland, Florida — Riverside, California

#PF - 13

FOOD MACHINERY AND CHEMICAL CORPORATION
FORM-CRETE Department
LAKELAND, FLA. • RIVERSIDE, CALIF.

Please send me a copy of your latest catalog.

Name_____

Company_____

Street Address_____

City_____ Zone_____ State_____

What's in a name?

In some cases, you'll never know. In other cases, it's clearly evident. Here, in the above illustration, you have the obvious and the obscure. Two reels of what appear to be identical prestressed strand. At this point, the similarity ceases.

It is from this point that most buyers of the "guess who" strand are strictly on their own. In most cases they can't find out who made it even when they want to. Except to learn that it comes—like cinnamon—from a distant shore. If something goes wrong, these buyers find that they get nowhere at all when they pick up the telephone and ask for the Distant Shore Operator.

Our illustration is not in any way big enough to show you what is behind, and *what preceded* the reel that identifies itself, and the superior product that is on this reel. It's difficult to *show* fourteen years of experience in the prestressed concrete field, to show the engineering knowledge and assistance that is yours whenever you want or need it. It's all there, though, and you can get it by communicating with Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, N. J.

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

Consult Roebling... First in the U.S. with Prestressing and Tensioning Elements